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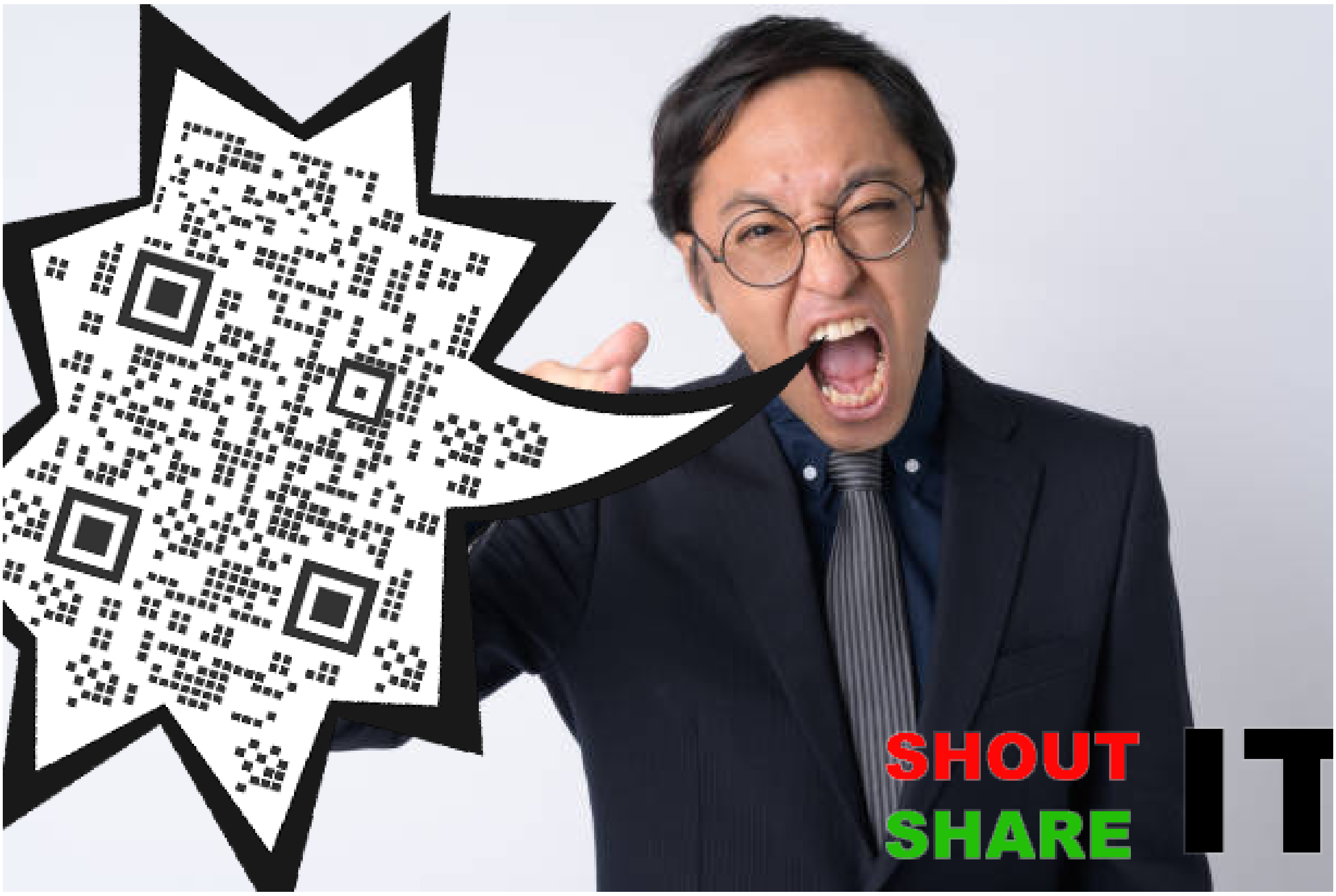
URBAN FORESTS: A GLOBAL PERSPECTIVE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URBAN FORESTS: A GLOBAL PERSPECTIVE

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CONTENTS

List of contributors .... **v**
Executive summary .... **vi**

Introduction **1**
1. Urban forests: a perspective from Latin America and the Caribbean **5**
  1.1 Context 6
  1.2 Governance 11
  1.3 Instances of participation in urban forestry 16
  1.4 Experiences in Latin America and the Caribbean 19
  1.5 Future opportunities: the Guadalajara Action Plan 26

2. Urban forests: a perspective from North America **37**
  2.1 Introduction 38
  2.2 Advances in organization and coordination 39
  2.3 Advances in capacity 43
  2.4 Advances in standards and metrics 60
  2.5 Advances in management and science 63
  2.6 New directions 71

3. Urban forests: a perspective from the Asia-Pacific Region **79**
  3.1 Population growth, economic growth and urbanization 80
  3.2 Sustainable development and sustainable urbanization 82
  3.3 Urban forests and sustainable urbanization 83
  3.4 Urban forests canopy cover change in Australia and New Zealand 86
  3.5 Urban forests for native biodiversity in Aotearoa – New Zealand 91
  6.6 China: 30 years of urban forest development 95
  3.7 Urban forests for cooler cities in Malaysia 101
  3.8 Singapore: six decades of urban greening 106
  3.9 The way forward for urban forests 113

4. Urban forests: a perspective from Europe **115**
  4.1 Introduction 116
  4.2 Networking 119
  4.3 Urban forests as nature-based solutions 120
  4.4 Development of novel forest ecosystems 121
  4.5 Spatial planning 123
  4.6 Policy framework 124
  4.7 Governance 126
  4.8 Social equity 128
  4.9 Health and well-being 131
  4.10 New approaches to urban forests through an ecosystem service-lead approach 133
  4.11 Conclusions 134

5. Urban forests: a perspective from the Near East and North Africa 139

5.1 Urbanization patterns in the Near East and North Africa 140
5.2 Sustainable urban development in the NENA Region – challenges and strategies 141
5.3 Living systems model and the integration of green infrastructure in urban development 142
5.4 Urban farming as a tool to mitigate losses of urban green spaces and agricultural land encroachment in Cairo, Egypt 144
5.5 Urban Micro-Lungs – mini-forests for climate, biodiversity and well-being in Amman, Jordan 149
5.6 Urban and peri-urban forests in Tunisia – a case study of the innovative Sidi Amor peri-urban forest project 153
5.7 Al Fay park – a paradigm shift in urban forestry in the United Arab Emirates 161
5.8 The way forward 164

6. Urban forests: a perspective from sub-Saharan Africa 169

6.1 Introduction 170
6.2 The context of urban forestry in SSA 170
6.3 Nature and magnitude of benefits from urban forests in SSA 175
6.4 Trends and innovations emerging in urban forests across SSA 179
6.5. Future trends and opportunities to scale urban forestry in SSA 191
6.6 Conclusions 194

Conclusions 217

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Executive summary

The main goal of this publication is to provide a snapshot of the current state of urban forestry around the world and inspire individuals and communities by sharing insights and experiences in urban and peri-urban forestry (UPF) from different regions. From the regional perspectives we can show how the approach to urban environments is undergoing a transformative shift, transitioning from holding cities accountable for environmental degradation to recognizing their potential as biodiverse and cultural arks.

Each region covered in this publication has a unique environmental, cultural and socioeconomic context, leading to the development of distinct perspectives and strategies in UPF. There are differences in the approaches to urban forestry between regions that have experienced slow and gradual urbanization and those undergoing sudden and exponential growth. For instance, in North America and Europe, urbanization was a steadier process, peaking around the mid-20th century. As a result, these regions have long recognized the importance of urban forestry and urban greenery, and have developed specific policies, financing mechanisms and well-defined decision-making processes that have fostered an enabling environment for increasing green areas in cities. North America, for example, laid the foundations for UPF through organizational coordination and federal investments, while Europe’s effective governance models (e.g. the Boscoincittà Park in Milan, Italy) and promotion of social equity (e.g. the Picasso Food Forest in Parma, Italy) have led to other significant advancements.

Advanced research on ecosystem services, tree species selection and emerging technologies have significantly contributed to optimizing UPF practices by enhancing our understanding of the benefits of urban nature and providing evidence-based guidance. Remote sensing, combined with data analysis, e.g. the i-Tree tool, has assisted North American countries in identifying suitable locations for tree planting and monitoring the growth and health of urban forests. With tools like the Tree Equity Score, the United States of America is now trying to address environmental injustices by identifying areas with limited access to green spaces and by prioritizing interventions to ensure an equitable distribution of urban forest benefits.

Urban and peri-urban forestry offers multifunctional benefits that positively impact both the environment and human well-being by providing recreational areas, reducing stress and enhancing social cohesion, as observed, for example, in the initiatives of the Natural Health Service in the United Kingdom. In addition, urban forests can be used to mitigate the risk of natural disasters and contribute to climate change adaptation strategies, thus making cities safer and more resilient.

To effectively give these multifunctional benefits, collaboration among stakeholders is essential. Initiatives based on direct community proactiveness are particularly significant because they result in actions that address residents' specific needs, foster a sense of ownership, and encourage long-term support towards urban forests and trees. Indeed, bottom-up approaches to urban forestry have been the driving force in sub-Saharan African countries for a long time. Unlike the Near East and North Africa, which tend to follow a top-down approach with limited public participation, sub-Saharan Africa's communities themselves initiate urban reforestation initiatives, often led by women. This situation occurs because in these countries, the intrinsic importance of trees holds meanings, tied to spiritual and cultural values that differ from Europe and the United States, where green spaces are more associated with social and recreational services. Indeed, some tree species in sub-Saharan Africa are considered spiritual mediators and hold deep significance in the lives of local communities, serving as symbols of identity, heritage and cultural practices.

In cities like Nairobi (East Africa), trees are also of fundamental importance for provisioning services, which lead to widespread urban foraging practices, including the collection of various products such as firewood, traditional medicines and wild foods. While urban foraging serves as a poverty alleviation strategy for many city residents, it is often prohibited or discouraged by city authorities, highlighting the need for policy and regulatory reforms to support local needs. Such policies should recognize the subjective value of UPF in different contexts, and provide incentives for its integration into planning and urban development frameworks, especially in countries where green spaces are considered a luxury.

Other types of challenges, arising from sudden and exponential urbanization, are particularly evident in some countries such as China and Kuwait. The massive influx of people from rural to urban areas in recent decades has resulted in the loss of natural areas, leading to the degradation of urban ecosystems and a decline in the quality of life for residents. Additionally, there are cases where not only rapid urbanization, but also particularly harsh environmental conditions complicate the implementation and maintenance of urban forestry initiatives.

In arid cities, such as those located in the Near East and North Africa (NENA), the urban heat island (UHI) effect and climate change impacts are exacerbated by water scarcity, high temperatures, predominantly desert environments, and frequent sandstorms. Given these circumstances, the expansion and preservation of green spaces are not only important but fundamental for achieving sustainable urban development. Greening these arid regions will provide important benefits, such as mitigating the UHI effect through shading and cooling, conserving water resources by reducing evaporation, and facilitating water infiltration into the soil. Trees and vegetation also protect soil from erosion, stabilizing it and acting as a natural barrier against strong winds that otherwise lift loose sand and threaten urban areas and infrastructure. Research and local knowledge become critically important for successful urban forestry implementation in arid environments. Demonstrating the significance of advanced research on native and climate resilient species, notable achievements include the ecological design of Al Fay Park in the United Arab Emirates (UAE) and the establishment of Miyawaki mini-forests in Amman, Jordan. These exemplary projects have been made possible through collaborations between the UAE and Denmark, and between Jordan and Japan, respectively, demonstrating how cross-regional cooperation can stimulate innovation by adapting successful strategies from other regions to local contexts while avoiding potential pitfalls.

This publication, although not exhaustive in scope, can serve as a useful resource for cities worldwide, inspiring them to adopt, adapt and expand sustainable urban forestry strategies.

Introduction

In recent years, urban forestry has taken centre stage in the global conversation surrounding sustainable city planning and development. As we approach the **2nd World Forum on Urban Forests** in Washington DC in October 2023, the theme "*Greener, healthier and happier cities for all*" could not be more relevant. It validates the importance of urban nature in creating inclusive cities and societies, in which the advantages of and services provided by urban forests and trees should be universally accessible.

World Forum on
Urban Forests

SAVE THE DATE

2nd World Forum
on Urban Forests

Greener, healthier and happier cities for all
Washington DC, 16-20 October 2023

Organizers: FAO, Arbor Day Foundation, the US Forest Service, Smithsonian Institution, City of Washington DC, ISA, Politecnico di Milano and SISEF

This Forum is not the first of its kind. In 2018, Mantova in Italy hosted the **1st World Forum on Urban Forests**, which attracted over 600 delegates from more than 70 countries. The Forum highlighted how urban forests contribute to sustainable economic growth, health enhancement, environmental conservation, social cohesion and public engagement.

Between these two global events, our understanding of the role of urban forestry in shaping healthier and more resilient cities has grown exponentially. Innovative concepts, such as the 3-30-300 rule, envision a world where everyone can see at least three trees from their window, reside in a neighbourhood with at least 30 percent tree cover, and live no more than 300 metres away from high-quality urban green spaces. Rapid advancements in technology are making it easier to collect spatial data for urban forestry planning and monitoring while governments worldwide are committing funds to urban forestry programmes, recognizing the key role that trees play in boosting urban resilience and improving the well-being of people.

Prominent international bodies have also recognized the importance of urban forests. The Intergovernmental Panel on Climate Changes (IPCC) Sixth Assessment 2022 Report, for example, highlighted the value of ecologically sustainable urban planning and infrastructure design. Interventions such as green roofs, park networks, urban forests, urban agriculture and water-sensitive designs emerged as key tools for both mitigation and adaptation to climate change within urban environments. The UN Decade on Ecosystem Restoration, which will continue until 2030, identifies urban settings as landscapes requiring restoration, a perspective that resonated at the XV World Forestry Congress in May 2022, where the role of urban forests in biodiversity conservation was emphasized in many high-level interventions.

FAO and its regional partners have boosted networking and knowledge exchange by organizing regional meetings across Africa, Asia, Latin America and the Mediterranean area. The European Forum on Urban Forestry has similarly pushed forward the regional dialogue and exchange in Europe, continually fuelling the regional networking and information dissemination.

The evolution of the global discourse around nature-based solutions, with urban forestry as a key component, has also been noteworthy. The Kunming-Montreal Global Biodiversity Framework (GBF), adopted in 2022 by 196 countries at the 15th Meeting of the Conference of the Parties (COP15) to the Convention on Biological Diversity (CBD) in Montreal, is a notable example. This framework aims to halt and reverse biodiversity loss by 2030 and advocate for the application of nature-based solutions to reach this ambitious goal, in particular, Target 12, *Increase the area of, access to, and benefits from green and blue spaces, for human health and well-being in urban areas and other densely populated areas.*

Moreover, major global city networks such as C40 Cities, the International Council for Local Environmental Initiatives (ICLEI) and United Cities and Local Governments (UCLG) have acknowledged the pivotal role that nature and green spaces play in enhancing urban life quality. In 2021, C40 Cities signed the C40's Urban Nature Declaration, committing further large-scale investments in urban nature to protect cities from the impacts of climate change and ensure that everyone has access to green spaces.

Cities worldwide are participating in programmes such as the Tree Cities of the World, a partnership between FAO and the Arbor Day Foundation that recognizes cities for being committed to managing their urban forests and trees. In 2023, four years after its launch, the programme recognized 170 cities from 20 countries for their efforts.

However, it is not all butterflies and rainbows.

Despite the advances, urban forestry still faces substantial challenges. Rapid urbanization worldwide, particularly in low- and middle-income countries, too often comes at the expense of natural resources and trees, undermining the important ecosystem services they provide. In certain areas, urbanization has occurred so rapidly and without real planning that it has resulted in urban communities being increasingly exposed to poor air quality, the effects of flooding and landslides, high urban temperatures, and lack of quality spaces in which to find recreation and improve social cohesion. Climate change further intensifies the impacts of unplanned urbanization and city administrators face the daunting task of providing urban communities with healthy and pleasant environments to live in.

These challenges are exacerbated by global events such as the COVID-19 pandemic, large-scale wildfires, increased flooding, record-breaking temperatures and escalating urban development. The risks and impacts of these anthropogenic events are particularly concerning in high-density cities, raising pressing questions about urban sustainability and resilience.

The acceleration of urban development has also exacerbated conflicts over land use, particularly where land is scarce, leaving less space for the implementation of urban green spaces. In addition to these factors, even in cities that recognize the importance of green spaces as part of their urban fabric, often the distribution of these spaces and the benefits they provide are skewed, with wealthier districts enjoying more extensive green coverage than their less prosperous counterparts.

Efforts to enhance urban forests worldwide encompass numerous strategies, including raising awareness through educational campaigns, promoting research and collaboration among stakeholders, ensuring active public engagement and providing equitable access to green spaces. In addition, technical assistance and capacity development should be offered, urban forestry integrated within policy development plans, and partnerships and knowledge sharing promoted among professionals and institutions. We must remember, however, that urban forestry is not a one-size-fits-all solution; each city and region, with its own unique set of challenges and opportunities, requires tailored strategies.

In recognition of the diversity and distinctiveness of urban forestry issues and their potential for mitigating environmental and socioeconomic inequality across the globe, we have asked experts around the world to share their views on how urban forests and trees are perceived and managed in their respective geographical areas, bringing together a broad range of regional perspectives. Our primary goal is to provide a comprehensive overview of the current state of urban forestry worldwide. By showcasing the regional perspectives, insights, experiences and case studies in urban and peri urban forestry (UPF), we hope to inspire individuals, communities and policy-makers to reimagine their relationships with urban green spaces.

We also hope that these contributions will foster a global dialogue that transcends boundaries and recognizes urban forests and urban greening as key contributions to our cities' resilience and to our collective well-being.

1

URBAN FORESTS: A PERSPECTIVE FROM LATIN AMERICA AND THE CARIBBEAN

“Sustainable urban models responding to the rapid urban growth”

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URBAN FORESTS: A PERSPECTIVE FROM LATIN AMERICA AND THE CARIBBEAN

1.1 Context

As in all regions of the world, Latin America and the Caribbean (LAC) is experiencing a growing diaspora from rural to urban areas, coinciding with the global migration phenomenon, where more than half of the population of LAC now live in cities, and by 2050, it will surpass 80 percent. The Economic Commission for Latin America and the Caribbean (ECLAC) reported that the population grew from 168.3 million inhabitants in 1950 to 660.3 million people in 2022, which is 8.3 percent of the world's population, two-thirds of whom live in cities with 20 000 or more inhabitants. The challenges of sustainable development are increasingly concentrated in urban areas, in low- and middle-income countries, where urbanization has occurred rapidly and spontaneously, without strategic plans and unsustainable land-use guidelines. The evidence of the unsustainability of urban growth generates the need to develop sustainable urban models that can respond to the growing demands for food and basic ecosystem services.

Many cities in LAC are experiencing rapid urbanization, which is causing an unprecedented loss of agricultural land and conservation areas (UNEP, 2010; Inostroza, Baur and Csaplovics, 2013; Rincón-Ruiz *et al.*, 2019). Uncontrolled urban development also leads to the depletion and degradation of natural ecosystems, a dramatic loss of fundamental ecosystem services, and potentially insufficient resilience to disturbances such as those caused by climate change. Social inequalities in the region's cities are among the highest in the world (UN-Habitat, 2016). These issues, together with their diverse geographic and climatic contexts, make these cities among the most vulnerable to future climate changes (Hardoy and Pandiella, 2009). Many countries in the region also experience high rural-urban migration due to conflicts (e.g. in Colombia; Rolnik, 2014; Rincón-Ruiz *et al.*, 2019) and increased economic pressures from globalized markets (Topik, Frank and Marichal, 2006). Despite these challenges, cities such as Curitiba (Brazil), Medellín (Colombia), San José (Costa Rica), Buenos Aires (Argentina) and Santiago

(Chile) are well-known global case studies in environmental sustainability (C40, 2019; ICLEI, 2019). Many of these cities are also paying attention to the urban greening agenda, particularly urban forests (Escobedo *et al*., 2008).

Regional and international cooperation

In order to support cities worldwide to continue enjoying the benefits of urban and peri-urban forests, the Food and Agriculture Organization of the United Nations (FAO) initiated a collaborative process to develop voluntary guidelines aimed at optimizing the contributions that forests and trees make to sustainable urban development. In this context, scientists, professionals and public officials from cities around the world held a series of workshops to discuss key elements and challenges of Urban Forestry.

In LAC, the process began in 2008 in Bogotá with an international meeting involving participants from Europe, Asia-Pacific and North America to share experiences regarding tree cover in their respective cities. The Bogotá Declaration (FAO, 2009), the outcome of this first meeting, promoted the establishment of networks and actions with an emphasis on fighting poverty and food insecurity in developing countries and agreed on the need to establish a collaborative and multilateral process to formulate guidelines for municipal decision-making aimed at promoting urban and peri-urban forestry. Five key priority sectors and their respective actions were identified: strategic processes and instruments in UPF; research; knowledge transfer and information dissemination; participation and empowerment of people's capacity for action; and the creation of a continuum of design, planning and management of UPF.

Among the specific recommendations for LAC, it was proposed to hold meetings to establish a regional network that would include all stakeholders in order to share knowledge, technical competencies, and promote UPF through key priority and strategic actions at the local, national and regional levels. Hence, three meetings were held: in 2017 in Lima, Peru; in 2019 in Bogotá, Colombia; and after a forced break due to the pandemic in 2022, in Guadalajara, Mexico.

Arboriculture associations

The organizational setting for urban arboriculture in LAC has undergone a transformative shift over the past few decades. An increasing number of countries has recognized the need for associations dedicated to promoting the professional practice of arboriculture, with pioneers such as the **Brazilian Society of Urban Arborization** (SBAU, 1992) and the **Mexican Arboriculture Association** (AMA, 1999) leading the way. Recently, several other nations have taken the initiative to form their own dedicated associations, all working towards the common goal of raising awareness, and conducting research in the arboriculture field. Some noteworthy examples are: the **National Arboriculture Association** (ANA, 2020) in Argentina, **the Colombian Arboriculture Association** (ACA, 2010) in Colombia, AUA, 2016) in Uruguay, the Costa Rican Association of Arboriculture (**ACRA**, 2018) in Costa Rica; the **Chilean Arboriculture Society** (SOCHAR, 2018) in Chile, the Peruvian Association of Arboriculture and Urban Forestry (**APA**, 2018) and the **Peruvian Association of Urban Ecosystems and Arboriculture** (APEUA, 2019) in Perú; the **Bolivian Arboriculture Association** (ABA, 2019) in the Plurinational State of Bolivia and the **Ecuadorian Arboriculture and Biodiversity Association** (AEAB, 2020) in Ecuador.

In general, these associations are dedicated to promoting the professional practice of arboriculture through education, knowledge sharing, research and certification. This aims to raise awareness among society about the benefits of urban trees and forests and strengthen the need for their conservation and care in order to improve the quality of life for city dwellers as an adaptation measure to climate change. Moreover, in 2020, the national associations of Ecuador, Brazil, Colombia, Peru, Costa Rica and Argentina created the **Latin American Arboriculture Council**, following the model of the European Arboriculture Council, with the aim of managing and promoting internationally recognized standards for green infrastructure implementation in decision-making in both the public and private sectors, for the benefit of people, trees, and those who work with them.

Bridging institutions and communities in urban forestry

With regard to the formation of the networks, in the continental area there is an active network called the Latin American Institute of Arboriculture, whose aim is to share experiences in dendrology, arboriculture and UPF. In addition, in 2013, the Caribbean and Central American Botanic Garden Network was created. In Bogotá Declaration, it was also recommended to hold national conferences to analyse and propose improvements for the promotion and implementation of UPF. An example is the **Argentine Forestry Congress** in 2023, which included an urban forest symposium. There are also successful institutional arrangements and valuable experiences in planning and implementing UPF programmes. However, it must be acknowledged that the integration of UPF planning into national forestry plans and the institutional agenda of cities in the region is still in its early stages. There is also a significant need to enhance participatory processes in UPF initiatives. Community participation in UPF is insignificant in most cases, with very few exceptions, which are usually led by universities, non-governmental organizations (NGOs), or professional associations. While the interests and decisions of authorities and specialized institutions, and support from scientists and professionals are crucial, they alone cannot achieve the objectives of proper UPF management. To this end, it is essential for LAC that local communities take ownership of such projects.

New perspectives on urban forestry research

In the last decade, there has been a significant increase in scientific production related to UPF. However, the trend remains to focus on the study of individual trees in public areas (streets and parks) as the primary unit of analysis. The urban tree canopy in LAC cities is generally composed of exotic species, creating an imbalance with native species. Mistletoe and some specific pests and diseases are the most common phytosanitary issues, none of which pose national-level emergencies. However, the health management of trees in urban areas remains a challenge. Understanding the urban forests of the region could be strengthened by expanding research to multiple units of analysis, thus providing a better understanding of regional spatiotemporal dynamics. In doing so, research could also cover a broader range of ecosystem services provided by urban forests and their relationship with poverty, crime, climate vulnerability, biodiversity loss and social equity. Research aimed at assessing the environmental functionality of urban forests in the region and their impacts on public health is still largely unexplored. A study conducted by Ordoñez *et al*. (2019), which reviewed and analysed over 55 000 documents from 13 countries published in English, Spanish and Portuguese between 1970 and 2018, highlights that most of the articles were ecological studies (64 percent) that used field studies (58 percent) to investigate urban vegetation diversity. Most ecological studies did not include any social or management considerations. Only a few studies focused on spatiotemporal dynamics (12 percent) or direct stakeholder opinions (9 percent).

Nevertheless, efforts continue with the generation of knowledge by recognizing tree species present in LAC urban areas, through the development of descriptive guides, such as the ***Tree Guide of Tucuman*** (Grau and Kortsarz, 2017). However, the implementation of georeferenced censuses that allow for a deeper understanding of urban forest assets remains uneven in the region. Such inventories, which can be carried out using modern technologies and appropriate methodologies with a common conceptual framework, should be implemented as a baseline for formulating cities' UPF master plans. Technical advice from cities that have already conducted such inventories is available and could be extended through the regional network. Being a region composed of low- to middle-income countries, research on UPF in LAC requires a lens focused on the local realities of its cities (Dobbs *et al*., 2019), different from those used in higher-income countries, which takes into account the environmental, social and economic characteristics of the Global South (Shackleton, 2012; FAO, 2016).

1.2 Governance

A literature review on the dynamics of urban and peri-urban Forestry governance in LAC reveals how the performance of formal institutions, mostly local governments, is closely related to the characteristics of their internal operations such as budgets, personnel, and strategic policies (Tovar-Corso, 2007; Fiedler *et al*., 2006; Locastro *et al*., 2017). However, several key governance topics related to urban forestry, including development models, policy implementation and monitoring, trees in private urban areas, climate change impacts, biodiversity restoration, and native tree species selection, are often inadequately integrated (Young, 2013; Zivojinovic and Wolfslehner, 2015; Almas and Conway, 2016; Grado, Measells and Grebner, 2013; Davies *et al*., 2017; Ordoñez *et al*., 2021; Devisscher *et al*., 2022).

Empirical studies in some cities in LAC, based on the perspective of local government professionals, indicate that when a broader range of stakeholders participate in collective decision-making, disparities in their professional capacities may hamper the process (Tovar-Corzo, 2013). Addressing this challenge, political leadership from local governments can serve as a catalyst by facilitating better stakeholder coordination. This approach has been exemplified by the Metropolitan Agency of Urban Forests (AMBU) in Jalisco, Mexico, a government-led urban planning initiative. Launched in 2019, AMBU aims to standardize green space management and establish a network of parks in the Metropolitan Area of Guadalajara (AMG), including the 13 largest parks spanning 431.94 ha. The parks' maintenance relies on a combination of public and private resources, which is a prerequisite for network inclusion, ensuring their long-term maintenance. However, the role of political leadership in UPF within the LAC context is somewhat opaque, affected by lack of trust and transparency issues regarding local governments (Pineda-Guerrero, Escobedo and Carriazo, 2021).

To explore how stakeholders working in UPF in LAC define urban forests, perceive management and governance issues, and identify educational opportunities, Devisscher *et al*. (2022) conducted an online survey. Ninety-one respondents from 50 cities primarily defined urban forests as parks, planted green corridors, street trees, natural forests, and peri-urban forest patches. Few respondents included in their definition private gardens, green roofs and walls, and urban farms; only 20 percent considered grassy playgrounds as part of urban forests. There was a consensus that operational resources (e.g. planting, species lists) and management tools (e.g. clear regulations) were generally available in cities. However, views diverged regarding the availability of tree inventories on private land and the various aspects of public involvement, which encompasses educational initiatives and the level of trust in governmental entities. Some prioritized public engagement in decision-making, while others focused on operational issues such as tree species lists and clear regulations.

Another challenge identified in the survey is the limited professional capacity in relevant institutions, which is directly dependent on the availability of education programmes. In LAC, conferences and workshops are the most common options for education on UPF, while certification programmes for arborists and training in best practices are not widely accessible in all cities. The lack of regulation of the arborist profession in the region leads to a lack of undergraduate programmes in arboriculture. As a result, UPF management in LAC is typically handled by forestry engineers, agronomists or biologists, although in many cases, individuals without training or competence are involved.

Doc Árbol: Empowering the next generation of arborists

"**Doc Árbol**" is a free distance training programme developed by **Reforestamos México** and the Mexican Tree Foundation for young people aged 18 to 35 who are interested in arboriculture and urban afforestation projects. It started in 2019 as an alternative during the COVID-19 pandemic to increase technical capacities and improve job and entrepreneurial opportunities. To date, over 200 young people from nine countries in Latin America and the Caribbean have been trained through more than 76 hours of thematic online classes. They have also received mentoring and guidance from experts in the design of projects related to plant production, tree inventories, environmental education and public space rehabilitation. In 2022, two projects were selected to receive support of USD 3 000 each.

It is clear that education and training are key to developing professional capacity in cities in LAC. However, there needs to be a shift from tree-focused capacities to system-level capacities, encompassing urban forest vision as an integral part of urban planning and governance. This approach can enhance professionalization and the future vision of UPF in LAC, as achieved in other regions of the world (O'Herrin *et al.*, 2020).

Over the past ten years, there has been an increasing focus on creating urban forest inventories, education and training materials, disseminating and implementing of best management practices, and on recognizing the value assigned to the urban forest. This amplified focus on urban forests has highlighted the importance of public participation in their management and governance.

Urban forest management is not just a technical problem to be solved by professionals, but also encompasses broader community issues such as public perception and support for urban forests. Public involvement is a key factor in the administration of urban forests, since it influences changes in human behaviour and can also provide valuable data for monitoring. Devisscher *et al*. (2022), in fact, observed that public consultation should become mandatory in many UPF activities. However, some stakeholders, may lack the knowledge, resources, or requirements in their organizational mandates to address public participation effectively, or they may be unable to address it due to a lack of capacity (staff, budget, knowledge and skills). Therefore, there is a need for more research in different urban forest management contexts, particularly concerning social inequality and urban environmental issues. Understanding how to strengthen UPF for better decision-making and governance is vital to effectively manage urban forests in the region.

The regulatory framework

A robust regulatory framework plays a pivotal role in fostering and safeguarding environmental rights and responsibilities, which is a fact strongly underpinned in the LAC region with the implementation of the seminal Escazú Agreement (CEPAL, 2018, 2023). Initiated on 22 April 2021, this environmental treaty was crafted with an explicit emphasis on ensuring the universal right to a healthy environment. It provides for improved access to environmental information, encourages active participation in environmental decision-making processes, and guarantees access to justice in environmental affairs. The introduction of the Escazú Agreement has thus marked a significant stride in bolstering environmental governance across the LAC region.

However, in LAC, the regulatory framework for the planning and management of UPF is fragmented and lacks an overarching regional law that would integrate the issue into primary forestry strategies of individual countries. Instead, the regulations often originate at the local level and gradually progress towards the regional level. As a result, many cities have their own regulatory provisions to organize various forestry activities, including UPF. For example, in Argentina, there are provincial laws that delegate UPF management responsibilities to municipalities or local governments. Therefore, each municipality establishes its own ordinances. A similar situation occurs in Colombia, where environmental authorities have their own specific regulations for UPF.

A few countries have taken significant steps to establish national laws that focus on UPF and related environmental issues. These laws serve as important frameworks for protecting and preserving urban trees and promoting a healthy environment. Notable examples include Puerto Rico's urban forest law of 1999, Paraguay with its law on the protection of urban trees enacted in 2013, and Cuba's forest law of 1998, which affirmed statal ownership of the forest heritage, including urban forests. In addition, in Cuba, the Ley del Sistema de Recursos Naturales y del Medioambiente (Law on the System of Natural Resources and the Environment,

2022) reinforces people's rights to enjoy a healthy and balanced environment, while the Ley de Soberanía y Seguridad Alimentaria y Nutritional (Law on Food and Nutritional Sovereignity and Security, 2022) promotes agroecology as a means for sustainable food production in cities, closely linked to the presence of trees in urban agriculture production systems.

In general, national regulatory proposals not only address the topics already discussed, but also aim to include issues such as economic valuation; promotion, planning and management at the national level; protection and conservation through mechanisms of social participation; financing; and standards to be achieved for the development of urban green infrastructure as a contribution to sustainable development. Overall, these legislative efforts demonstrate a commitment to enhancing urban forestry and environmental stewardship within the LAC region.

Environmental justice

Throughout LAC, access to green areas or wooded areas varies greatly, especially in metropolitan areas and neighbourhoods with high vulnerability, limited access, unsatisfactory basic services and security issues. Often, their distribution and accessibility make them out of reach for residents, preventing them from being used for their intended purposes. In contrast, wealthier areas have access to forests and other ecosystem services that contribute to a better quality of life, with landscaping and environmental investments that are not found in peripheral neighbourhoods. Ensuring accessibility to urban forests for everyone is essential in order to reduce environmental inequity and its social repercussions.

Concerned about environmental justice, several cities in Brazil, i.e. São Paulo, Rio de Janeiro, São José dos Campos, Curitiba, Jundiaí, Recife and Campo Grande, are using risk management indicators to plan the management of urban forests. Perhaps one of the few successful examples of extending tree coverage to the most disadvantaged sectors in the periphery, in terms of urban design and management with environmental quality, is the city of Maringá in the State of Paraná, southern Brazil.

Public health and well-being

According to Faggi *et al*. (2018), in recent decades, green areas in LAC have become spaces for promoting healthy habits and ecological education, and fostering physical and cultural activities. Actions have been taken in old and forgotten green public spaces that are now used by the population, or in new places created by the community, such as Sofia Forest and the Bikers Pocket Park in the historic centre of Curitiba, Brazil. Although Curitiba is now considered a model of an ecologically sustainable city, it is interesting to note that few of its original policies had an explicitly environmental purpose; rather, they were the result of cost reduction measures. Objectively, urbanization also offers significant opportunities for sustainable development if managed correctly, providing an occasion to turn deficits into opportunities where green spaces become vibrant places for fostering health promotion actions. Many cities throughout LAC are implementing programmes based on multiple strategies to promote a healthier lifestyle through sports in green spaces, such as: in Buenos Aires, Argentina (Macri, Chain and Lastri, 2009); Bogotá, Cali and Soacha in Colombia; Quito, Ecuador; and Zapopán in Mexico, with the promotion of bicycle use (Sarmiento *et al*., 2010).

Other new initiatives are emerging to meet increasing public demand, such as "Pajariando", a birdwatching programme in Bogotá's wetlands, Colombia. This activity allows carefree attention and contributes to mental restoration. The wetlands, disputed between developers and conservationists seeking to preserve these remnants of natural ecosystems, have gained public attention because they are among the last surviving natural ecosystems in Bogotá. To date successful restoration efforts have reclaimed 540 hectares (ha) (Brodzinsky, 2014).

Although there has clearly been a shift towards public action that utilizes green spaces for both active and passive recreation, objective measures and epidemiological research are still needed to turn these observations into factual assessments that will influence the development of public health policies in our cities.

1.3 Instances of participation in urban forestry

Urban Forest Fora – Community integration

Three Urban Forest Fora have been organized in LAC, serving as platforms for participation and collaborative work in urban forests and green spaces (Figure 1).

In 2017, the inaugural *Latin American and Caribbean Forum on Urban Forestry* was inaugurated in Lima, Peru, as a response to the New Urban Agenda's demand for sustainable urban development actions. It facilitated discussions among international, regional and local stakeholders on decision-making processes, best practices and opportunities for the appropriate design, establishment, maintenance, and restoration of urban forests and green spaces in the region. By addressing a wide spectrum of topics, from city governance to urban forestry's impact on human well-being, it succeeded in linking influential figures and institutionalizing the forum as a space for exchanging ideas and generating action plans.

The second Latin American and Caribbean Forum on Urban Forestry convened in Bogotá, Colombia, in 2019, expanded on the context provided by the outcomes of the First World Forum on Urban Forests, held in Mantova in 2018 (i.e. the Call to Action and the Tree Cities of the World programme). This event served as a call-to-action platform, emphasizing objectives such as fostering a working network for urban forests, improving information dissemination, advocating for urban forestry in the political agenda, and promoting environmental education. Key topics included international collaboration, urban-rural linkages, biodiversity conservation, research networks, management and monitoring practices, and the ecosystem services offered by urban forests.

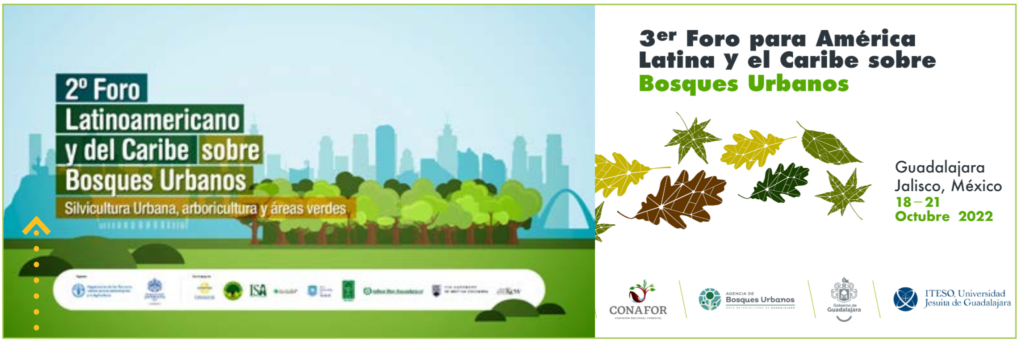
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Image 1. Promotional material from the fora

The third Latin American and Caribbean Forum on Urban Forestry, held in Guadalajara, Mexico in 2022, built on previous discussions and sought to spotlight positive examples of planning and management across diverse regional contexts, in order to optimize the contribution of urban forests to local conditions. The forum facilitated the consolidation of the Guadalajara Action Plan for Urban Forests in Latin America and the Caribbean, focusing on thematic areas such as green jobs, climate resilience and food security.

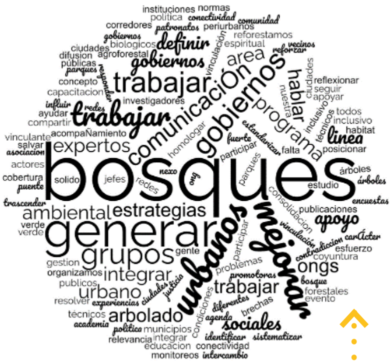
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Image 2. Word cloud generated from participants' comments in the discussion space of the Second Forum in Bogotá, 2019

Each forum witnessed participation from at least 11 LAC countries and was coordinated by organizations such as FAO, the Latin American Development Bank, and the National Forestry Commission of Mexico, among others. These gatherings have significantly advanced the sustainable development of urban forestry across the region, fostering inclusive dialogues, and nurturing an ambitious vision for the future. Their impact is evident in the creation of a recognized platform for sharing ideas, the push for standardized urban forest management methodologies, and the implementation of the Guadalajara Action Plan.

In conclusion, the three urban forest fora held in LAC have made significant strides in the sustainable development of urban forestry and green spaces across the region, and have also inspired a compelling vision for the future. Each forum has nurtured inclusive dialogues, established clear objectives, and garnered the active engagement of international, regional and local stakeholders.

Looking forward, the future of urban forestry is intrinsically linked to the continuity of these dialogues and the effective implementation of the insights they yield. It is hoped that these Urban Forest Fora will evolve into permanent discussion platforms, similar to the European Forum on Urban Forestry. This evolution would undoubtedly strengthen ongoing efforts to foster green economies, reduce disaster risks, promote health and well-being, and ensure food security in urban development.

The Tree Cities of the World programme in Latin America

In a global effort to acknowledge cities dedicated to the creation and preservation of urban green spaces, the **Arbor Day Foundation** (ADF) and **FAO** established the **Tree Cities of the World** programme. This initiative recognizes urban areas committed to enhancing their green canopy, which brings numerous ecological and socioeconomic benefits to their communities.

In 2022, the programme celebrated the efforts of 170 cities from 21 countries, with a significant representation of 44 cities from LAC, underscoring the region's commitment to greening urban spaces. To receive the "Tree City" designation, a city must meet five essential standards: have a dedicated authority responsible for the care of trees; implement regulations to ensure the protection and expansion of urban trees; maintain and share information on urban trees and green areas; allocate a dedicated budget for managing and increasing urban trees; and commemorate the significance of trees with celebratory events.

The impact of the programme in 2022 was noteworthy, with LAC cities under its aegis reporting significant advancements in greening efforts. A total of 1 218 823 trees were planted, and an investment of almost USD 107 million was made towards these initiatives. Furthermore, the programme benefited over 35 million people and volunteers contributed 220 363 hours of their time to different activities. Indeed, the Tree Cities of the World programme serves as a beacon of hope for cities worldwide, encouraging them to invest in greening initiatives that can significantly improve urban life.

1.4 Experiences in Latin America and the Caribbean

National policies in Urban Forestry

Urban ecological parks in the Dominican Republic

In the Dominican Republic, the management of urban trees is carried out in three areas: trees in parks or public squares; reforestation of public areas such as green areas and avenues at city entrances (roundabouts); and artificial forests through reforestation of former wastewater treatment plants and of landfills sites. Additionally, ecological restoration of degraded urban and peri-urban ecosystems is undertaken. This approach allowed the creation of many urban ecological parks, which differ from other urban reforestation projects because they focus on restoring degraded natural resources or ecosystems. These parks encompass remnants of old forests, lagoons, rivers, and urban and peri-urban gallery forests.

Over the course of 13 years, many of these ecological parks have lost their condition due to occupation and changes in land use, highlighting the need for ongoing maintenance and protection of these parks. In order to guarantee long-term commitment in managing and preserving these areas, some cities have incorporated the ecological parks into the National System of Protected Areas

(SINAP). Examples include the Manantiales de Laguna Prieta ecological park in the province of Santiago, the Boca de Nigua and Laguna San José National Recreation Area, located in the provinces of San Cristóbal and San Pedro Macorís, respectively.

Approximately 100 ecological parks are in the process of being restored and established in different cities of the Dominican Republic, with an emphasis on wetlands and urban watersheds. The involvement of different stakeholders in protecting ecological parks demonstrates the importance of collective efforts in ensuring long-term viability of these protected areas.

Overall, the management of urban ecological parks has highlighted the importance of recognizing the ecological services provided by these ecosystems and the need for collaboration between municipal governments and national authorities. By aligning their efforts, they can coordinate actions to ensure the long-term viability of these protected areas. This cohesive approach strengthens the effectiveness of management initiatives and facilitates the integration of urban and peri-urban ecosystems into broader conservation and urban planning frameworks.

The role of institutions in urban forestry management in Cuba

In Cuba, there are several institutions involved in urban forests. At the provincial level, a governmental group composed of local government agencies ensures that service infrastructure does not interfere with urban green infrastructure. The **Institute of Agroforestry Research** implements projects for planning, management and conservation of urban trees in Havana, where they have established a typological classification based on planting sites, which was validated in the field. This classification allows for standardizing terms and definitions, thus creating a common language among all stakeholders. Each typology is based on floristic inventory, phytosociological characterization and phytosanitary status, which leads to diagnosis and an action plan for the recovery and comprehensive maintenance of urban trees.

In addition, for the first time in the country, the cataloguing of unique trees was implemented based on exceptional qualitative criteria of selected individuals. In some cases, the carbon retained in the tree biomass was determined, and the relationship between tree diversity and environmental resilience to the effects of adverse weather events was assessed. This approach demonstrated the need to consider their instrumental value due to their important role in preventive environmental regulation. As a result, this has allowed for evaluating the stability of forests and tree-covered spaces in typologies that encompass planted or naturally established trees, while considering urban environmental protection and sociocultural activities. The management of urban trees in Cuba aims to adapt its structure to ensure the maximum level of benefits for the residents.

Regional and local policies for urban trees

Regional policies in Brazil

Since 2007, the State of São Paulo has implemented the Green–Blue Municipality Program, which measures and supports the efficiency of environmental management in its 645 municipalities. This programme assists in the development of strategic public policies for the sustainable development of the State, with goals and incentives for planning and management, together with success indicators.

Another initiative at the state level, resulting from the collaboration between professional associations, public agencies, and the Public Prosecutor's Office of the State of Paraná, was the creation of the Interinstitutional Work Commission for the analysis of municipal urban afforestation plans in the State. In 2012, they developed a manual for the formulation of these plans, promoting their production in the State's 399 municipalities.

Case study: governance in Bogotá, Colombia

Since 1998, Bogotá has implemented a progressive regulatory framework and a decentralized institutional architecture involving 29 out of its 45 institutions, coordinated by an environmental authority. Georeferenced information on silvicultural activities carried out on urban trees is produced by the mayor's offices, water and infrastructure companies and the Botanical Garden responsible for afforestation. These data, monitored by the environmental authority, feed into the Urban Tree Management Information System (SIGAU), a georeferenced census repository that the city launched in 2008.

Since 2018, each locality in Bogotá has in place an Urban Afforestation Plan, which encompass various tree-related actions citywide. These actions include annual planting of 10 000 trees, maintenance of 80 000 young and adult trees, integrated pest and disease management of 6 000 trees, risk mitigation by replacing dangerous trees (3 600 trees), and the creation, recovery and maintenance of green areas. The city also has implemented a Pruning Plan, with an average of 164 000 trees pruned annually, enabling precise monitoring and maintenance cycles to minimize deterioration. These initiatives, alongside institutional strengthening, community involvement and knowledge dissemination, comprise the District Plan for Urban Forestry, Green Areas and Gardening (2019–2030), equivalent to the Master Plan defined in FAO's *Guidelines on urban and peri-urban forestry* (FAO, 2016). The Plan is integrated into government development plans and the Environmental Management Plan, which is valid until 2038.

To implement the UPF Master Plan and manage 1.2 million trees, Bogotá allocates annual budgets for: administration (USD 1 346 000), risk management (USD 2 390 000), silvicultural activities (USD 93 750), pruning plan execution (USD 7 900 000), planting (USD 1 250 000) and maintenance (USD 3 600 000).

Challenges in Bogotá include the implementation of plans, monitoring of silvicultural work, information management, and updating of the urban tree census. With regard to planting, there are challenges related to the appropriate use of locations in relation to the planted species, species selection and adaptation, and low community participation. These challenges result in an average annual mortality rate of 34 percent, which is excessive and should be controlled.

Furthermore, the city faces the challenge of reversing the constant loss of tree coverage, defined as the projection of the tree canopy on the ground, which since 2008 has already affected 160 ha. Another hurdle is reducing the significant disparity in environmental services offered by urban trees between the northern and southern areas of the city. In the southern area, there is an average of 11 residents per tree, while in the northern area, the ratio is 4.6 residents per tree. This situation is mainly caused by a lack of environmental determinants in different planning instruments and land use, preventing urban processes that promote the generation of green areas, combined with low institutional capacity for evaluation, monitoring and control of urban development.

Finally, Bogotá needs to focus on technical training, including having UPF in the curriculum for forestry professionals, and on improving social communication due to the high impact that tree felling, pruning and relocation activities have on the community. These activities often generate social discontent because of a lack of understanding of the benefits of proper maintenance through pruning or relocation, or the effective management of risk through emergency pruning and felling or technical handling.

Bogotá has embarked on research initiatives to address key challenges and advance understanding in urban tree management. Three studies, out of a total of 21, have already produced results. These scientific advances include strategies to mitigate the effects of heat islands through urban tree coverage, an assessment of the taxonomic and functional ecological value of Bogotá's trees for biodiversity conservation, and the development of a tree dumping model within the city. Through these research initiatives, Bogotá aims to inform evidence-based decision-making, enhance the effectiveness of its urban tree management practices and further contribute to sustainable urban development.

Women in urban forestry

Experiences in Cochabamba, Plurinational State of Bolivia

The involvement of women in urban forestry activities has been most relevant in Cochabamba, Plurinational State of Bolivia. A group of women from the forestry and environmental field saw opportunities in cities to develop their knowledge and skills in forest management. They took the lead and currently engage in urban forestry activities from different spheres, including public services, the business sector and environmental activism. The actions of this female group began in 2016 when they proposed the development of a Forestation Master Plan for the city, which was accepted by the municipal authorities. They later drafted municipal regulations for the management and protection of trees, with the support from environmental groups. This movement opened up new opportunities and markets for the creation of pruning and tree management service companies, and even ventured into academia by offering technical courses.

As a result of these initiatives and the implementation of regulations, the importance of public tree management and governance has gradually been recognized by both the population and the state. This experience, with its achievements and lessons learned, has become an important reference in Plurinational State of Bolivia, as many cities in the country have followed Cochabamba's example in urban forestry.

Women arborists in Latin America and the Caribbean

The first time that women participated in a LAC Tree Climbing Championship was in October 2018. In 2019, Magaly Saya, a Puerto Rican arborist with over 30 years of experience in urban tree work, interviewed the participants to promote mutual support. She encouraged Mónica Martínez, a Mexican arborist, to form a stronger group to engage in activities that were traditionally considered only for men. Over time, they included another arborist from Spain, Vanessa Tilán, and founded the group of Women Arborists of Latin America (MALA). They climb trees, work together, and receive training to provide quality work combined with sisterhood and camaraderie. Currently, 45 women from Argentina, Plurinational State of Bolivia, Chile, Colombia, Costa Rica, Ecuador, French Guiana, Mexico, Peru, Puerto Rico and Spain are part of the group.

They manage their processes internally and have recently established themselves as a civil association (2022). As such, they have a work agenda and plans for training their members. The group includes women of different sexual orientations, transgender women, and women from different ideological and physical backgrounds who share a love for tree work and have all been marginalized in the sector, mainly by men. One common aspect is that they have created several lead teams of women climbers. However, they are more involved in administration, tree diagnosis and the development of management plans. They expect the group to grow to meet the needs identified by women for better preparation and competition.

Communication campaigns to engage the public

Since 2020, with the onset of the COVID-19 pandemic in Brazil, the Brazilian Society of Urban Forestry (SBAU) has been organizing conversation circles to facilitate discussions between technicians and experienced individuals in urban forestry topics. These circles are conducted in collaboration with Universidade Federal do Pampa (UNIPAMPA) and Fundação Universidade Federal de Mato Grosso do Sul through virtual discussion and published on social media. They usually involve three or more people discussing topics such as the benefits and social functions of urban trees, seedling production, soils, roots and pavements. These conversations, with the participation of Brazilians and experts from LAC, have become highly successful in terms of viewership.

"Tree Week" in Argentina is a campaign for very large planting, donation and adoption of native trees. It is promoted by the Argentine Chapter of the Club of Rome, La Ciudad Posible, and the Water and Youth Movement. Since 2012, it has been celebrated during the last week of August, commemorating National Tree Day. It is a voluntary action in which hundreds of institutions and thousands of people participate. In 2020, the organizers launched a new initiative, the "Million Trees", whose aim is to double the previous efforts and contribute more to the fight against the ecosystem and climate crisis. It seeks the active participation of all municipalities, towns and communities in Argentina to plant and care for one million trees in a coordinated manner.

The "Forest Vision and Time Sentinels", which began in Mexico in 2016, is a photography contest aimed at encouraging, promoting and disseminating an appreciation for forest ecosystems and majestic trees through photography. It is developed by Reforestamos México and the National Forestry Commission and has received 39 829 images of trees and forest landscapes. In 2022, a prize pool of over USD 25 000 was awarded.

The private sector and tree production in urban areas

In Brazil, some engineering companies are entering the tree market, operating nationwide. Other notable landscaping private companies, in partnership with the University of São Paulo (USP) and funded by the Ministry of Science, Technology and Innovation (MCTI) and the Funding Authority for Studies and Projects (Finep), are developing the digital system "Arbolink", which utilizes artificial intelligence for urban tree management and is meant to be incorporated it into city planning and management.

Most of the nurseries that produce trees for urban afforestation, ranging from 2 to 6 metres in height, are located in Monterrey and Nuevo León, Mexico. Interestingly, the National Power and Light Company in San José, Costa Rica, produces around 4 000 trees annually ranging from 2.5-m to 6-m, and supplies them to cities throughout the country at competitive prices. In Colombia, there is only one nursery producing trees of these dimensions, located in Luruaco, a town near Barranquilla, and it is part of the `'Siembra" Institutional Project, whose aim, from 2020, is to produce 12 000 trees per year to support the city's afforestation. A new venture has also emerged in Asunción, Paraguay, where a notable nursery produces trees for residential areas and condominiums using the air-pruning propagation system. Air pruning occurs naturally when roots are exposed to air in the absence of high humidity and is a low-cost, efficient method of propagating cuttings, seedlings or container plants for restoration projects. The State of São Paulo (Brazil) has also advanced in tree production for urban areas, with a notable nursery having an average production of 5 000 trees per year, including ornamental and fruit trees, both native and exotic.

In general, the production of high-quality trees for urban areas in LAC cities still requires greater investments. Currently, they rely on trees produced for ornamental purposes that do not fully meet the technical specifications of height and physical conformation required to withstand such hostile environments as urban ones. This is one of the most influential causes of mortality when planting new trees, which in some cities is repeated in the same locations, thus highlighting the waste of funding dedicated to this activity.

1.5 Future opportunities: the Guadalajara Action Plan

Exemplifying the power of collective collaboration, the third Latin American and Caribbean Forum on Urban and Peri-urban Forests (2022) formulated and launched an extensive action plan – the Guadalajara Action Plan (GAP). This comprehensive plan integrates the insights and outcomes from prior discussions and fora, laying a solid foundation for proactive measures related to urban and peri-urban forests.

The GAP is a result of a concerted effort, bringing together governments, civil society, neighbourhood organizations, academia, youth and forestry management professionals. It seeks to implement the recommendations from the second Regional Forum and actualize the Call to Action from the 2018 World Forum on Urban Forests. Its ultimate goal is clear: to catalyse the creation of cool and climate-resilient cities; foster biodiverse and multifunctional urban forests, thus contributing to food security; endorse urban forests that further livelihoods for fairer and more equitable cities; and champion healthy and clean forests for the well-being of all people. To translate the Call to Action into reality in the region, the GAP integrates actions that align with several key goals: to raise awareness of urban forests' value; to support decision-makers in managing their green capital; to encourage participatory governance for urban forest management; and to enhance technical capacities in UPF-related areas.

The actions included in the GAP are summarized and can be categorized under four areas of intervention.

1. PUBLIC POLICIES AND LEGISLATION FOR GOVERNANCE	
Issue: Gaps in national and regional legislation on UPF. Disconnected urban forest planning from urban development programmes. Limited public budget. The challenge is to have effective legislation and public policies, and achieve citizen participation.	
ACTIONS	**EXPECTED RESULTS**
1.1 Organize spaces for exchanging experiences on legislation related to urban forests.	The capacity of governments, civil society organizations, citizens and other stakeholders are developed and strengthened to influence relevant regulatory frameworks for UPF.
1.2 Prepare a document on “basic elements for legislation on urban forests”.	Guidelines have been prepared for national and subnational legislation to develop regulations on urban forests.
1.3 Develop initiatives for the creation or modification of regulations in UPF.	Proposals have been made that include activities such as assessments, conservation and maintenance.
1.4 Institutionalize social inclusion and citizen participation, with a gender perspective, in processes related to urban forests.	Citizens participate in the development and implementation of public policy. Through the translation of regulations into local languages, the participation of Indigenous Peoples is strengthened. Women’s capacities in forestry are strengthened.
1.5 Promote participatory urban forest management plans with short-, medium- and long-term actions.	Urban forests in Latin America and the Caribbean (LAC) have specific instruments for their sustainable management.

2. EDUCATION AND TRAINING

Issue:
There is a need to democratize education and training in the field of urban forests and trees, making education accessible to all stakeholders. Collaboration networks should be formalized for the generation and dissemination of information, materials and guidelines to improve decision-making and empower citizens.

ACTIONS	EXPECTED RESULTS
2.1 Include UPF in the curriculum of educational institutions at different levels.	Universities have expanded their educational offerings with programmes that include relevant subjects for urban forest management.
2.2 Assess capacities and technical and educational needs for managing UPF.	The training needs of all actors involved in urban forest management are identified.
2.3 Create a platform for continuous training.	The platform allows for the implementation of training programmes for different actors.
2.4 Organize technical professionalization workshops.	Government operational staff have strengthened their technical capacities for UPF management.
2.5 Reactivate the FAO platform for freely accessible educational materials.	Citizens and other interested actors have access to freely available educational materials.

RESEARCH
STRATEGY
URBAN FORESTRY

3. RESEARCH

Issue:
Challenges and direct needs have been identified. It is necessary to generate research focused on participatory decision-making.

ACTIONS	EXPECTED RESULTS
3.1 Develop an *Urban Forest Atlas*	Information on the diversity and distribution of urban tree species, their characteristics, endemism, and appropriate management is updated.
3.2 Develop a methodological guide for assessing the environmental, social and economic services of urban forests in LAC.	Technical tools have been developed for assessing the ecosystem services of urban trees that consider health and diversity conditions; provide useful information to create a regional database on the state of the art of UPF.
3.3 Create an observatory of urban forests in Latin America and the Caribbean.	Working groups from academia have been formed and meetings have been scheduled between university actors, citizens, professional technicians and decision-makers.
3.4 Create a technical–scientific repository on urban forests.	A manual or tutorial on the use of Dgroups is published, which centralizes information and dissemination materials for working groups.
3.5 Compile good practices on FAO's Dgroups platform.	A tutorial on how Dgroups works has been created.
3.6 Integrate citizen science laboratories.	University open working groups focused on forest-related activities for monitoring by citizens.
3.7 Develop a diagnosis of research needs.	Research in the region is oriented towards identified needs. Documents are available on relevant technical and research topics to address tree-related scientific issues specific to the region.

4. COMMUNICATIONS

Issue:
There is a widespread lack of knowledge about the management of urban forests in the environmental agenda.
Dissemination of information on activities and actors involved in UPF is very limited management.

ACTIONS	EXPECTED RESULTS
4.1 Conduct a mapping of actors that includes experts and successful references in UPF, as well as potential spokespersons and "influencers".	A database of relevant actors and spokespersons for urban forests, according to the region or locality has been set up, in order to facilitate their role in the implementation and dissemination of actions.
4.2 Design a communication strategy on urban forests.	A strategy is developed that includes priority and relevant topics for ongoing communication, while considering the diversity of target audiences.
4.3 Develop manuals or guidelines to facilitate communication on UPF.	Documents have been developed in accessible and appropriate language to facilitate mass communication focused on diverse audiences.
4.4 Create audiovisual materials for disseminating science related to urban forest management.	Links have been strengthened between academia and communicators. Academics share materials, organize webinars and create discussion spaces with citizens, organizations and technicians to disseminate specialized information.
4.5 Map and promote media outlets to disseminate information on urban forests.	Media agencies have spaces and/or environmental-themed programmes in the mass media to increase public awareness about UPF.
4.6 Conduct an LAC campaign directed at mayors and grassroots organizations that promotes outstanding actions regarding UPF.	Citizens are recognized and motivated to participate in the care of urban forests. Hence, more local authorities are interested in promoting policies and programmes because this recognition serves as an incentive.

Overall, during the third Forum (Photo 1), participants engaged in discussions and dialogues exercise to provide inputs on concrete actions that can drive tangible changes in the region leading up to the upcoming World Forum on Urban Forests in Washington D.C., United States, on 16-20 of October 2023, and the Latin American gathering. These concerted efforts will drive the implementation of the GAP, translating the Call to Action into a tangible reality in the region, and fostering cooler, climate-resilient cities and biodiverse and multifunctional urban forests that contribute to food security, and promote livelihoods for fairer and more equitable cities.

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Photo 1. Latin American and Caribbean Forum on Urban and Peri-Urban Forestry

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2

URBAN FORESTS: A PERSPECTIVE FROM NORTH AMERICA

“A vision for healthy urban forests and vibrant communities”

AUTHORS

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URBAN FORESTS: A PERSPECTIVE FROM NORTH AMERICA

2.1 Introduction

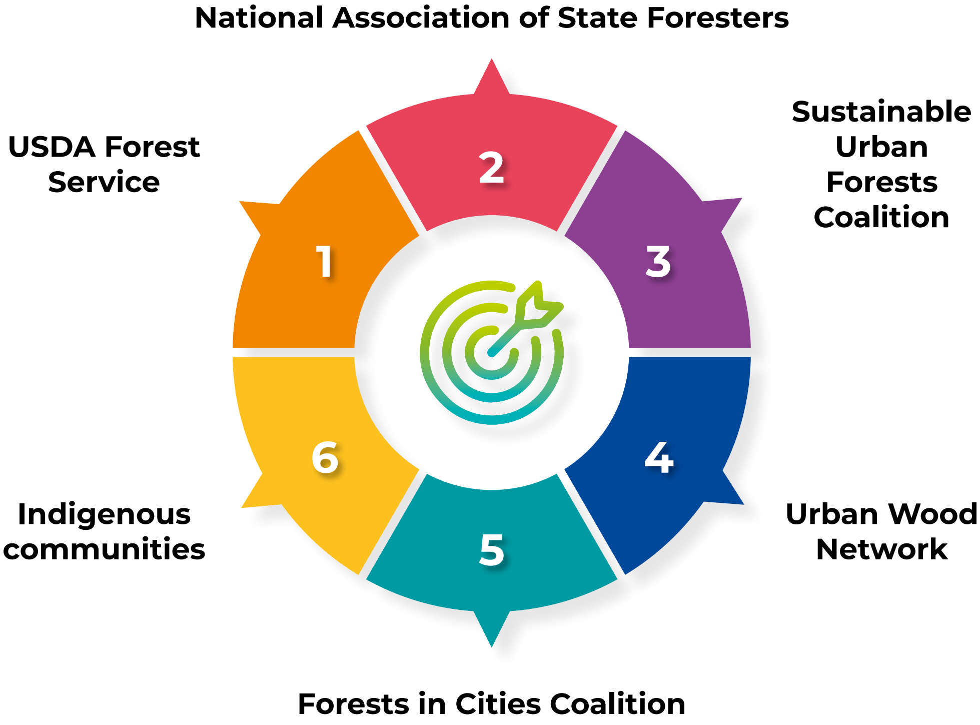
The past five years in North America have been a remarkable period of growth for urban and peri-urban forestry (UPF). This chapter will focus primarily on recent advances in organization, capacity, standards, management and research in the United States of America, Canada and Mexico. As a snapshot in time, we also highlight the threats and opportunities facing the region's urban forests, and the new directions that are taking shape. Our intent is to be comprehensive but not exhaustive for this inaugural report.

The North American region has shown steady growth in awareness and commitment to urban forests since the term was first coined by the Canadian forestry professor Erik Jorgensen in 1965. The emotional and ecological loss of the iconic American elm tree (*Ulmus americana)* in eastern cities of the United States of America and Canada was a significant catalyst for local and federal policies and investment in urban forestry in the 1970s, including the later passage of the 1990 Farm Bill, which established the current Urban and Community Forestry Program in the United States of America. Insects and diseases, now magnified by climate change, continue to drive local, regional and federal actions to restore public safety, beauty and ecological value from declining tree and forest conditions. Today, 50 years later, it is the emerald ash borer (*Agrilus planipennis*) that has galvanized regional and national attention in its impact on nearly all *Fraxinus* species, many of which were planted in cities to replace the lost American elm.

Recent advances in high-resolution imagery (circa 2010) and the many **research findings** (e.g. Endreny, Sica and Nowak, 2020) that tree canopy cover is unevenly distributed across cities – corresponding with disparities in wealth and race, and heat exposure and mortality in vulnerable populations – have overtaken such issues as pests and diseases in the scope and scale of public response. This discovery has led to a cultural awakening, fresh voices, and new priorities for investment in "tree equity" within cities across the world. We prepared this chapter amid a global climate crisis and federal response in the United States of America, Canada and Mexico, where our forests, especially those right outside our front door, are seen as "nature-based solutions" to a host of ills facing cities today.

2.2 Advances in organization and coordination

The key to advances in urban and peri-urban forestry (UPF) within North America has been the response of remarkable organizations and the coordination of programmes that support, monitor, communicate, organize and deliver action through partnerships at all scales.


National Association of State Foresters
USDA Forest Service
Sustainable Urban Forests Coalition
1
2
3
6
5
4
Indigenous communities
Urban Wood Network
Forests in Cities Coalition

1

The US Department of Agriculture Forest Service

This response has been facilitated by the **US Department of Agriculture (USDA)** programmes, which have been instrumental in developing innovative management tools and initiatives since 1974. Annual tracking since 1990 has shown that communities receiving federal and state technical assistance tend to advance towards more sustainable and resilient tree care programmes and populations. These communities are now more likely to understand what they have (e.g. tree inventories and canopy assessments), how to accomplish the work (e.g. operations, management and action plans), and which strategies to use in order to grow and sustain tree populations (e.g. planting and maintenance). The USDA Forest Service has also fostered communities of science and practice through its network of regional offices, research stations and urban laboratories (**field stations**) that have supported steady advances in the fields of urban forestry and urban ecology across the North American region and the world.

2

National Association of State Foresters

As regards the national leadership in urban forestry, the **National Association of State Foresters** (NASF), established in 1920, has played a crucial role in advocating and developing policies and forest action plans to manage and protect state and private forests, including urban forests. As a non-governmental organization composed of the directors of forest agencies in the 50 states, the NASF has fostered collaboration among state foresters to facilitate the development and delivery of USDA Forest Service programmes, and to resolve regional and national policy and funding issues through three regional state forester groups: the **Southern Group of State Foresters**, the **Western Forestry Leadership Coalition** and the **Northeast/Midwest State Foresters Alliance**. State urban forestry coordinators have been frontline personnel in providing technical and financial assistance to local partners in establishing, maintaining and expanding effective urban forest and tree care programmes.

3

The Sustainable Urban Forests Coalition

Since 2004, in addition to the national and state-level efforts, the **Sustainable Urban Forests Coalition** has been instrumental in bringing together a diverse network of non-profit organizations, businesses, associations and charitable foundations dedicated to promoting healthy urban and community forests. Their collective efforts have fostered awareness and increased tangible support for urban forests and the programmes that sustain them. Each stakeholder in the Coalition has a strong independent voice, but altogether the network represents a volunteer force for advancing sound, effective urban forest policy and practices at national to local levels.

4

The Urban Wood Network

Other notable advances in leadership and coordination in the North American region are represented by the Urban Wood Network (UWN) and the Forests in Cities Coalition. Established in 2017 to promote the utilization of urban wood and remove it from the waste stream, the **Urban Wood Network** brings together municipal arborists, tree care companies, sawmills, manufacturers, consultants and other interested partners. The UWN has unified many sectors to establish and support full circle urban forestry management by fostering a robust supply chain and facilitating the best possible use of urban wood resources.

5

The Forests in Cities Coalition

The Forests in Cities Coalition resulted from the efforts of the **Natural Areas Conservancy** in New York City. Through partnerships and research initiatives, the Coalition is enhancing the management of forested natural areas in 17 metropolitan areas across the United States of America. Their efforts include developing a community of practice to enhance the management of 730 000 hectares of forests embedded in urban landscapes, informing on urban forest management best practices, and studying the cooling potential of urban natural areas in order to contribute to the development of climate-resilient strategies.

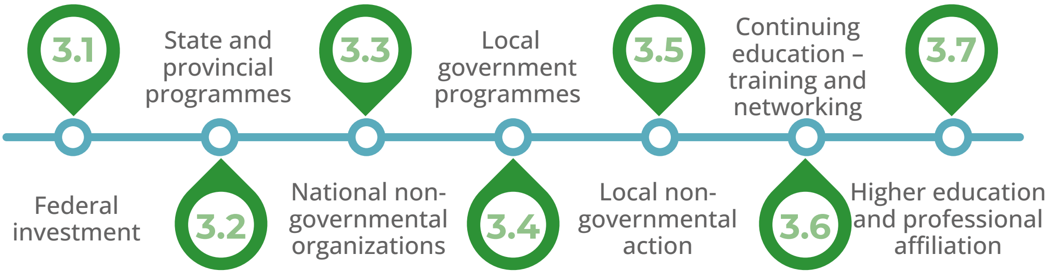
6

Indigenous communities

Advancement in urban forestry through Indigenous communities is gaining momentum. Traditional practices of growing and utilizing plants and trees for sustenance and shelter have been prevalent across North America for centuries. There are many examples of community forestry being practiced as an integral part of local culture. Examples such as the **Menominee Indian Tribe of Wisconsin** (United States of America) showcase the importance of sustainable forest growth for harvesting wood and traditional products. Indeed, their forests have more standing timber today than in the past, and their tribal forestry operations have provided employment through 150 years of **sustainable forestry**. Another example is the Blackfeet Nation in Montana, United States of America, which was the first tribal community to be recognized as a **Tree City of the World**. The cultural and community importance of trees and forests has a long history, and the sharing of **traditional ecological knowledge (TEK)** related to their stewardship continues to grow.

2.3 Advances in capacity

The growth in commitment to UPF at all scales of governance in North America has been driven by local needs and demands for assistance. Community tree management is the responsibility of property owners and local governments across the region. Public commitment is manifest through volunteer engagement and public spending levels to grow capacity and sustain tree planting and maintenance efforts.


3.1
Federal investment
3.2
State and provincial programmes
3.3
National non-governmental organizations
3.4
Local government programmes
3.5
Local non-governmental action
3.6
Continuing education – training and networking
3.7
Higher education and professional affiliation

Federal investment

The United States of America has had steady growth in local investment catalysed in many ways by national leadership listening to state and local voices. Congress-authorized funding for forest research in urban areas started in 1974, and subsequent legislation consolidated a broad range of forestry assistance to states – fire and forest management, forest health, wood utilization, urban forestry and other assistance – under the USDA Forest Service, State and Private Forestry Division. However, it was not until 1990, with the passage of the Food, Agriculture, Conservation, and Trade Act (commonly called the "Farm Bill") that specific federal authority and funding for **Urban and Community Forestry** (UCF) was established. The Farm Bill legislation also established additional mechanisms to guide policy, investment and capacity across the country. It created the **National Urban and Community Forestry Advisory Council** (NUCFAC), with representation from all sectors of UPF – a group tasked with writing and updating a **National Ten-Year Urban Forestry Action Plan** including **research and development**. To support the goals set out in the plan, the NUCFAC also implements a **National Urban and Community Forestry Challenge Cost Share Grant Program** through the USDA Forest Service, contributing up to USD 1 million annually to projects that develop programmes or tools (e.g. **i-Tree**) applicable to UPF practitioners nationally in support of the Action Plan.

In recent years, the Forest Service has also distributed funding for projects through the **Landscape Scale Restoration** (LSR) programme, facilitating collaboration across states and interest groups to solve specific land management issues. Project funding supports collaboration among various forestry professionals, including urban foresters, wildland fire professionals, wood utilization experts, nursery managers and researchers to address challenges across the spectrum of people–tree–forest issues.

An example of such collaboration is a cooperative project involving multiple states (New Mexico, Texas, Kansas, Nebraska and Oklahoma) that aims to address the challenge of a limited availability and selection of diverse and climate-adapted trees for urban forestry. The project brings together the expertise of nursery and genetics professionals to establish a partnership model for producing native seed from among a diverse set of tree species for local planting projects. It involves tree seed collection, testing, seed orchard establishment, and planting in partnership with commercial nurseries, arboreta and local governments.

Recently, the United States has received a significant funding boost for the Urban and Community Forestry (UCF) through the **Inflation Reduction Act** (Section 23003). The Congress authorized USD 1.5 billion in federal funds over 10 years to distribute to states, cities, non-profit community groups, universities and tribal nations (See section 6 - *New directions*). At least 40 percent of these funds must be allocated to economically or environmentally disadvantaged neighbourhoods and areas, as defined by the **Council on Environmental Quality's Climate and Economic Justice Screening Tool**. This funding is specifically targeted at capacity-building to address long-term challenges such as climate change, heat abatement in cities, expanding community engagement, and reducing environmental and economic inequities. This generational investment in capacity expands opportunities for the USDA Forest Service to work directly with national partners, cities and community-based organizations.

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Photo 1. Philadelphia, Pennsylvania green stormwater infrastructure

In Canada, the federal government has made a significant investment in urban forestry through the **2 Billion Trees (2BT) program** (2020–2030). This CAD 3.3 billion commitment aims to plant two billion trees by 2030 and includes competitive grants for urban capacity building. This programme has enabled **many smaller communities** to enhance their urban forests.

While the **National Forestry Commission** (CONAFOR) in Mexico does not have a specific mission for the management of urban forests, it has developed special guidelines within the **Mexican Forestry Fund** to channel resources for environmental compensation for land use change. This can include financing afforestation projects in urban areas, following the regulations established in the General Law for Environmental Protection in 2023.

State and provincial programmes

Many states choose to distribute their federal fund allocation as grants to community groups and local governments (e.g. cities, towns, villages, townships, counties) to build capacity at the local level. These competitive, matching grant programmes are often designed to provide an incentive for a local entity to expand urban forestry staffing, provide training, conduct tree inventories, draft management plans, establish public education programmes, and support other components of quality urban forestry management. Some states also have state-funded programmes for urban tree distribution and planting to complement the federal funding they distribute.

To support state programmes and foster collaboration, the USDA Forest Service maintains a network of regional urban forestry staff. These staff members provide support to state programmes, monitor grant accomplishments, and foster collaboration among the states in their region: the Northeast and Midwest, the South and the West. With guidance from the NASF and three regional collaboratives of state foresters, the state coordinators meet regularly with their federal counterparts to discuss programme achievements, share success stories, and collaborate on ideas to solve UPF challenges common to their respective geographies. Examples of successful projects through this interagency cooperation include: the ***Healthy Trees, Healthy Lives*** educational campaign promoting the positive links between trees, forests and human health; the ***Urban Forestry Economic Analysis*** detailing the contribution of UPF to state economies in the **Northeast and Midwest**; and a 2023 Publication on Resilience in the **Western Urban and Community Forestry** region, featuring stories of building resilient communities.

The province of Manitoba, Canada has a unique forest programme that includes an **Urban Forest Council**. The Council's objective is to promote arboriculture best practices, safe work, professional development, information-sharing and networking in Manitoba.

In Mexico, an example of state-level urban forest management is the **Agencia Metropolitana de Bosques Urbanos del Área Metropolitana de Guadalajara** (AMBU). This is a decentralized public body in the state of Jalisco, designed to conserve, protect and renew 12 forests and urban parks located in the capital. AMBU provides technical, scientific and legal support to conserve and improve forest connectivity, biodiversity, social integration and recreation, environmental education, infrastructure and fundraising. It provides support to nine municipalities where more than five million people live.

National non-governmental organizations

National non-governmental organizations (NGOs) have been critical leaders in educating and organizing constituencies, and raising private funding and corporate resources to support local actions and advocate for the need for state and federal investment. Below are just a few of the NGOs that have played an outsized role building a regional movement to plant and care for urban and peri-urban forests.

- **AMERICAN FORESTS (AF)** one of the oldest environmental organizations in the United States, has been a policy leader and advocate for urban forests since its establishment in 1875. AF pioneered the practice of urban tree canopy analysis and benefit quantification with their CityGreen software, and created the **Vibrant Cities Lab**, a resource hub for advancing local UPF programmes. Most recently, AF unveiled its **Tree Equity Score** tool, which highlights areas with the greatest need for tree cover and environmental equity.

- **THE ARBOR DAY FOUNDATION** (ADF), established in 1972, is now the largest member-based non-profit environmental organization in the United States, with more than one million members, donors and supporters. The ADF has created a community of practice across local governments and the private sector to support urban and community forests. The Foundation annually hosts the **Partners in Community Forestry** Conference, where professionals from various forestry sectors network and learn about the latest management options, technology and examples of partnership from around the world. In addition, the ADF offers various recognition programmes, including **Tree City USA**, which celebrates cities and towns that meet urban forestry standards. It also recognizes **colleges and universities, health care institutions** and **primary/secondary schools** in order to promote best practices in tree care. Furthermore, the ADF leads the **Tree Cities of the World** recognition programme, which brings together a global network of communities. Taken together, these recognition programmes bring together many of the property owners and managers that impact trees and forests. The ADF also partnered with the USDA Forest Service to develop **Energy Saving Trees**, a utility-to-consumer model for tree distribution that helps homeowners save energy. Local utility companies sponsor free trees for homeowners with i-Tree Design software, which shows the best place to plant trees for energy savings. Since 2011, more than 120 sponsors have distributed 450 000 trees to households nationwide.

© Photo courtesy of Arbor Day Foundation

Photo 2. Nashville, Tennessee

© Photo courtesy of Arbor Day Foundation

Photo 3. San Francisco, California

© Photo courtesy of Arbor Day Foundation

Photo 4. Miami, Florida

© Photo courtesy of Arbor Day Foundation

Photo 5. Greenville, South Carolina

- For more than 25 years, the **ALLIANCE FOR COMMUNITY TREES** (ACT), a programme of the ADF, has served as the national voice for the community-based organizations dedicated to planting and caring for trees in the United States. This network delivers on-the-ground programmes for tree planting, tree care, volunteer action, and learning and sharing among members.

- **THE NATURE CONSERVANCY** (TNC) is a convening partner of Sustainable Urban Forests Coalition (SUFC), which works in partnership across the region to create a world where people and nature can thrive. Their **North America Cities Network** is the newest force of 21 cities committed to supporting the voice and vision of local communities to co-develop innovative conservation solutions. In partnership with the USDA Forest Service and the University of Georgia, TNC developed the **Healthy Trees Healthy Cities** mobile application to educate and engage community residents in monitoring tree health. TNC scientists have played a significant role in identifying **nature-based services** (McDonald *et al*., 2016) provided by urban forests.

- **TREE CANADA** is the only national non-profit organization dedicated to planting and nurturing trees in rural and urban environments, in every province across the country. Since 1992, Tree Canada has helped to grow Canada's tree canopy through programmes, research and engagement efforts, and by offering grants to communities and schools. Tree Canada's mission is to help grow resilient ecosystems and healthier, greener communities across Canada.

© Photo courtesy of Tree Canada

Photo 6. 2022 Planting of trees under the Edible Trees grant

© Photo courtesy of Tree Canada

Photo 7. 2022 Partners in Planting event with UPS in Surrey, BC

© Photo courtesy of Tree Canada

Photo 8. 2022 Partners in Planting event sponsored by UPS in Surrey, BC

© Photo courtesy of Tree Canada

Photo 9. National Tree Day 2022 at the Montreal, QC, event on Mount Royal

© Photo courtesy of Tree Canada

Photo 10. National Tree Day 2021 at the Quebec City event; post-planting image

Established in 2002, **REFORESTAMOS MEXICO** is a civil society organization whose mission is to achieve sustainable development through thriving forests across all 32 states of Mexico. The organization, through the Trees and Cities team, has developed initiatives such as the Urban Tree Index, where cities are ranked in terms of tree condition, and the Tree Regulation Index, which ranks Mexican states in terms of their regulatory protection for urban trees and forests. Furthermore, Reforestamos Mexico promotes **Tree Cities of the World** and hosts a photography contest that seeks to identify the largest trees in the country and heritage trees in urban areas.

© Photo courtesy of Reforestamos Mexico

Photo 11. Mexico City urban reforestation

© Photo courtesy of Reforestamos México

Photo 12. Mexico City urban reforestation

Local government programmes

Most state and provincial governments recognize local governments – cities, towns, villages, boroughs, townships, counties and other political subdivisions – through home rule charters, so that local decision-making on issues, such as water, wastewater, police, fire protection and land use, are made by locally elected representatives rather than state legislatures. This structure enables cities to be at the forefront of UPF development in the region. Long before federal funding was made available, cities were developing their own programmes to plant, tend or remove trees on public property. A **US Conference of Mayors' report** on how they are leading on climate includes several examples focused on trees as a nature-based solution to extreme heat and flooding. An earlier **survey of 135 cities** illustrated many local examples, some of which are shown in Table 1.

Table 1. Examples of urban forestry initiatives in North America and Canada

CITY/REGION	DESCRIPTION
Milwaukee, Wisconsin	The city's Forestry Services in the Department of Public Works designs and manages approximately 200 000 street trees and is responsible for many green spaces, as well as beautification projects. Its successful programme for managing the emerald ash borer (EAB), is considered a model for the country.
New York, New York	NYC Parks manages public trees in the city and implemented the **MillionTreesNYC** initiative, a public–private partnership that planted one million trees across the city from 2007 to 2015.
Fort Worth, Texas	The city has a long history of promoting urban forestry practices, being the oldest and longest-running **Tree City USA** in Texas. The Parks Department manages public trees, while private property trees are regulated by the Urban Forestry Management Section of the Planning and Zoning Department.

Portland, Oregon	Urban forestry management falls under Parks and Recreation, which aims to manage 218 000 street trees, 1.2 million park trees and 2.9 million private property trees. The city has established ordinances, policies and regulations for private property trees in order to achieve city-wide goals for tree canopy.
Denver, Colorado	The Office of the City Forester oversees public tree management and development regulations to protect private trees. Denver's educational campaign for managing the emerald ash borer, called **Be A Smart Ash** engages residents in efforts to replace ash trees across the city.
Canada	Various Canadian cities have ongoing initiatives, such as the **Million Tree Challenge** in London, Mississauga and Winnipeg. Cities such as Oakville have set new standards in urban tree by-laws, promoting advancements and innovation in urban tree by-laws.
District of North Vancouver, British Columbia	The district has a new **Urban Tree Canopy Project** that supports residents living in apartments to plant trees and shrubs on balconies using funds from an environmental compensation fee.
Mérida, Yucatán, Mexico	The city developed the municipal **Green Infrastructure Plan**, aligned with the Municipal Development Plan, to promote the generation of information and indicators, the implementation of programmes and projects, promotion of environmental education, and the design of public policies for better governance regarding trees, among other elements that make up their green infrastructure agenda.
Toluca, Mexico	Toluca launched the **Citizen Network of Pollinating Gardens** to raise awareness on the importance of pollinating species. The city is part of the monarch butterfly migratory corridor, and the gardens contribute to connectivity between forested areas.
San Pedro Garza García, Nuevo León, Mexico	The municipality has an online platform for citizens' adoption of trees in the city, allowing residents to participate in tree planting initiatives and contribute to urban greening efforts.

Local non-governmental action

Community-based tree groups across North America are among local charities that have existed for decades, raising funds to deliver local programmes to benefit urban forests, such as tree planting, educational campaigns, volunteer management and, increasingly, efforts to create green jobs and promote environmental justice. New groups form regularly, while existing groups continue to grow and develop more sophisticated approaches to urban forestry programming. Tables 2, 3 and 4 showcase only a few examples of the different sized NGOs from more than 100 active organizations:

Table 2. Community-based tree groups and NGOs promoting urban forestry in North America

ORGANIZATION	LOCATION	DESCRIPTION
Friends of the Urban Forest	**San Francisco, California**	Founded in 1981, this organization has installed and maintained over 60 000 street trees, accounting for almost half of San Francisco's street tree canopy. It led a successful public awareness campaign and ballot initiative, which transferred the care of all street trees from fronting property owners to the Department of Public Works and allocated USD 19 million annually for street tree and pavement maintenance.
Trees Forever	**Iowa and Illinois**	Founded in 1989, it led the community planning process to develop the ReLeaf Cedar Rapids' long-range plan after a destructive storm in 2020. The plan aims to re-establish the lost tree canopy in Cedar Rapids and supports fundraising efforts.

Casey Trees	**Washington, DC**	Established in 2002, Casey Trees has become a leading non-profit organization focused on trees. It boasts a 40.5-hectare tree nursery, advocates for a 40 percent tree canopy goal for Washington, DC, conducts regular measurements of tree canopy, and monitors changes to inform tree policy through its annual **Tree Report Card**.
Sacramento Tree Foundation	**Sacramento, California**	Since 1982, this organization has been engaged with the community to plant and care for over 1.5 million trees throughout California. It has collaborated with the Sacramento Municipal (Electric) Utility District to distribute and plant more than 600 000 **free shade trees** since 1990 to reduce peak energy demand and lower household energy bills. It has been estimated that the energy savings of these trees is equivalent to building a new power plant for the region.

Table 3. Organizations that engage residents in greening and advancing local tree canopy cover in Canada

ORGANIZATION	LOCATION	DESCRIPTION
Collectif Canopée	**Quebec City, Canada**	Builds capacity to plant 10 000 trees in the Quebec City area.
Root for Trees	**Edmonton, Canada**	A volunteer tree-planting initiative in the City of Edmonton.
Sustainable Neighborhood Action Program	**Toronto, Canada**	Includes urban forests in its climate change solutions efforts.
ReForest London	**London, Canada**	Aims to enhance environmental and human health in London, known as the 'Forest City', through the benefits of trees. Inspires and empowers residents to plant and care for trees.

Table 4. Civil society organizations that protect trees and green areas in Mexico

ORGANIZATION	LOCATION	DESCRIPTION
Reforestación Extrema	**Monterrey, Nuevo León, Mexico**	A Civil society organization dedicated to protecting Monterrey's forest heritage through the implementation of good practices. Reforestación Extrema is recognized for its transformation of public spaces.
Fundación de Rescate Arboreo (FURA)	**León, Mexico**	A Civil society organization that aims to increase the number of green areas in León. FURA promotes a local advocacy agenda to influence municipal public policies to achieve its goals.
Bosque Urbano de Extra	**Jalisco, Mexico**	A civil society association founded in 2008 to improve air quality in Jalisco. Focuses on the production, donation and adoption of endemic and native trees for planting in public pavements, parks, gardens and private spaces.

Continuing education – training and networking

The growth in continuing education, training and networking opportunities has been exponential in the North American region since the seminal **National Urban Forestry Conference (1978)** in Washington DC, the **2023 World Forum on Urban Forests** is suitably hosted in the same location. Between these two dates, hundreds of state, provincial and national events have taken place. As a national model, the annual **Partners in Community Forestry Conference** hosted by the Arbor Day Foundation brings together coordinating organizations and local leaders to network and share model projects and lessons learned in a peer-to-peer framework.

Similarly, the **Canadian Urban Forestry Conference** provides a premier event hosted every two years by Tree Canada. The Conference links practitioners to subject matter experts in order to share innovative strategies, policies, technologies, research and best management practices in urban forestry.

FAO, Reforestamos México, the Instituto de Estudios Superiores de Occidente (ITESO), the Government of Guadalajara, the Metropolitan Agency for Urban Forests (AMBU), Bosque Urbano Extra, and the National Forestry Commission collaborated to organize the **Third Forum for Latin America and the Caribbean on Urban and Peri-urban Forests** in October 2022. A product of this Forum was the Guadalajara Action Plan (see the Latin America and Caribbean section), which established an agenda to promote urban forests in the region.

The ISA **Certified Arborist** and other industry credentials since the early 1990s have created a substantial demand for continuing education units (CEUs). Today, it is relatively easy to gather CEUs through in-person and virtual conferences and webinars associated with ISA state and country chapters. In addition, state and local tree-related educational events are hosted annually in conjunction with **Tree City USA** and state Urban Forest Council meetings.

Regarding continuing education, the Society of Municipal Arborists has been hosting a **Municipal Forestry Institute (MFI)** since 2006. MFI is a weeklong intensive educational programme for practising professionals to strengthen leadership skills in programme administration, coalition building, strategic thinking, programme planning and public relations. The newest edition to advanced learning is the **Green Communities Leadership Institute** which was developed and is delivered by active peers and conservation leaders in the profession. This is a "next level leadership opportunity that prepares community leaders to enact climate action, improve diversity, equity and inclusion and build lasting positive impact on environmental and community health".

Many university extension programmes, professional associations and the USDA Forest Service offer one-hour webinars that have been recorded and compiled into an extensive collection of current and advanced topics at each institution. These sessions can be viewed on-demand and attract a dedicated following. Important collections can be found at **Pennsylvania State University, University of Massachusetts-Amherst**, the non-profit **Urban Ecology Collaborative**, among others.

In Canada, the Kwantlen Polytechnic University in British Columbia is offering an **arborist technician apprenticeship** that combines on-the-job training and classroom learning. Certified arborist technicians work for municipal parks departments, school boards, golf courses and for private arboriculture companies, and are in high demand.

The **École forestière de La Tuque** in Quebec offers a new pruning educational programme, lasting 915 hours. It is given by professional teachers who have worked in the field for several years. At the end of the training, the student will have acquired the skills as a technician in arboriculture, urban forestry, forestry and nursery practice.

Higher education and professional affiliation

Formal educational opportunities in North America have been relatively stable, and primarily offered by state and provincial universities, community colleges and independent institutions. However, recent developments in the workforce include the emergence of arborist and urban forestry apprenticeship programmes. For example, in Canada, there has been a surge of research contending with multiple dialogues in urban forestry, notably around both social and ecological interventions and innovations.

This has led to a range of programmes and studies across colleges and universities. For example, the Canada-wide interuniversity and interdisciplinary graduate training programme in **Urban Forest Management** (Ufor) aims to train highly qualified professionals capable of managing the complex sociocultural and economic make-up of urban forests. The programme is centred on creating a national network of academics and partners who have a stake in urban forest training and professional development, and those who can offer training or internships to students.

Professional affiliations have also been critical to advancing education and practice in urban forestry across the North American region. Some affiliations supporting urban forestry include the **Arboriculture Research and Education Academy,** which facilitates communication and coordination among scientists and educators, and the **Society of Commercial Arboriculture**, which connects professional arborists through networking and educational events.

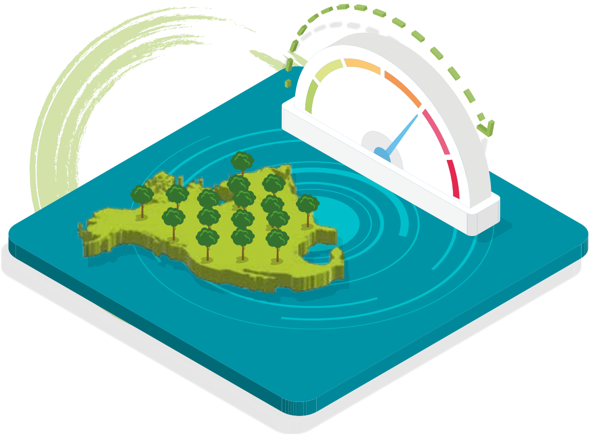
Another notable case is the **Mexican Association of Arboriculture** (AMA), which is an NGO created in 1999, with the purpose of promoting the practice and study of arboriculture, including certification of arboriculture professionals in Mexico. AMA has established and disseminated standards and practices in tree care.

© Photo courtesy of City of Durango, Mexico

Caption: Tree City of the World celebration in Durango, Mexico

2.4 Advances in standards and metrics

Baselines and changes



The municipal tree management assessments and **formal reports** (Hargrave *et al*., 2022) tell the story of change and the maturation of urban forestry practices in the United States of America. Initiated in 1974 by James Kielbaso at Michigan State University, the assessments were repeated roughly every 10 years to establish baseline data on local government programmes and inform the delivery of national and state technical and financial assistance. The collected data have been essential in understanding how communities of different sizes approach urban forestry while also highlighting areas for improvement within local programmes. The subsequent updates, with the most recent **completed in 2014** (Hauer and Peterson, 2014), revealed significant advancements in urban forestry practices. First, there has been a notable increase in staff expertise, with 61 percent of people living in communities have at least one staff member holding an **ISA Arborist certification**, a programme developed only 20 years earlier. Moreover, the incorporation of industry standards or credentials for contractor hiring decisions has become commonplace, with 72 percent of communities adopting this practice.

Regarding workforce compensation, the pay for field arborists has aligned with the national average for all occupations in the United States. However, city foresters earn 50 percent more, indicating the significance placed on their role in urban forestry management. The growth in tree care ordinances has been remarkable, increasing from 67 percent in 1974 to 90 percent in 2023. Especially noteworthy is the substantial rise in trees and development ordinances, with 54 percent of communities having some form of tree protection today, compared to a mere 11 percent in 1974. Assessing the tree population has become common, with 67 percent of the communities now possessing some knowledge about their tree populations through inventories – an increase from 21 percent in 1980. Furthermore, the adoption of management plans has increased from 11 percent to 50 percent between 1974 and 2023. Community engagement, although not tracked in the past, has become common today. Approximately 65 percent of respondent communities now involve volunteers in urban forestry activities, resulting in an estimated annual contribution of 1.5 million volunteer hours.

Despite the progress made over the past 50 years, certain challenges persist. One such challenge is the lack of tree diversity, with an average of 60 percent of the public tree population consisting of only six tree species. This situation highlights the need for further efforts to enhance and promote diversity in urban tree populations. Indeed, diverse urban tree species have the potential to enhance the resilience and overall health and sustainability of urban ecosystems by offering varied resistance and tolerance to pests, diseases and environmental stressors.

An important update to this work will be carried out in 2024 to continue the 50-year legacy. The work will incorporate new ways to assess urban forests and green spaces, the current status of tree diversity, and many more appropriate solutions to build upon a 50-year longitudinal assessment[1] of municipal forestry programmes.

Local programme management

Across North America, urban forest management ranges from proactive to reactive approaches. Many communities have transitioned from pencil and paper inventories to advanced systems like interactive geographic information systems (GIS), and machine learning for urban tree canopy analysis. The City of Los Angeles in partnership with **City Plants** exemplifies the successful combination of urban forest information and community needs. The Vibrant Cities Lab **Urban Forestry Toolkit** provides an interactive tool for developing and benchmarking local programmes. Additionally, the Arbor Day Foundation’s **Tree Cities of the World** programme extends recognition and incentives to local and tribal stakeholders to develop UPF management programmes beyond the United States.

i-Tree Tools

A steady series of assessments, applications, models and peer-reviewed papers co-developed with partner organizations and university institutions led to the development of the **i-Tree suite** of freely available tools. The suite of tools enables individual trees and their benefits and values to be assessed, priority planting areas to be identified, and tree canopy and land cover to be estimated. The integration of i-Tree with the USDA Forest Service nationwide continuous **Forest Inventory and Analysis** (FIA) Program allows to evaluate the environmental services provided by urban trees such as public health enhancement, carbon sequestration, air quality improvement and energy savings.

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[1] A longitudinal study is a research design that involves repeated observations of the same variables over long periods of time. It is often a type of observational study, although it can also be structured as a longitudinal randomized experiment.

A remarkable six-year study in Louisville, Kentucky was carried out using the i-Tree model and direct assessments in partnership with The Nature Conservancy. This was the first controlled experiment of its kind to test urban greening in the same way that a new pharmaceutical intervention would be tested (Yeager *et al*., 2023). The **Greenheart Project** research team first assessed the risk of diabetes and heart disease, stress levels and the strength of social ties among 636 participants from targeted Louisville neighbourhoods. The team also took baseline measurements of air pollution levels at the same time to measure the power of greenery as a public health strategy in Louisville neighbourhoods.

Recognizing the value of the i-Tree suite, a version called **i-Tree Eco** was adapted for Mexico with the collaboration of the **National Institute of Forestry, Agriculture and Livestock Research (INIFAP)**. For the adaptation of the suite, the project incorporated climate and pollution data from climatic stations, integrated new tree species, and collected data from 33 urban centres covering 83 percent of Mexico's urban population. In addition, the translation of manuals and software into Spanish ensured accessibility and usability in the country.

The use of high-resolution digital imagery has revolutionized the understanding of tree canopy dynamics across urban areas. By overlaying this information with property ownership maps, the concept of "**tree equity**" has emerged, leading to a shift from a public street tree focus to a parcel-based, all-lands approach[2] for planning and management. Many communities have assessed their canopy cover distribution, set goals and implemented initiatives to achieve those goals. Individual tree or sample-based inventories, such as **i-Tree Eco**, contribute to a comprehensive understanding of the urban forest's structure, function, resilience, biodiversity, and ecosystem services over time.

The Tree Equity Score

In an effort to address disparities in access to green spaces, the American Forests organization developed the **Tree Equity Score** tool. This tool highlights the inequities between different areas in terms of tree cover and green spaces, which are often influenced by historic injustices such as federal grading (or **redlining**[3]) of neighbourhoods (Nowak, Ellis and Greenfield, 2022). This has led to the awareness that more affluent areas often have more trees, tree cover and green spaces. Therefore, this situation clearly demonstrates that these newly marshalled spatial tools help visualize the problems and challenges while enabling us to know where we should focus our efforts. Climate change and particularly **extreme heat** events highlight the importance of not only recognizing these issues, but also actively working to find the solutions for alleviating these inequities through increased tree cover and more green spaces for all.

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[2] A parcel-based all-lands approach is a method that allows city land parcels with favourable land use conditions to build more green infrastructures than required, and trade their extra capacity as monetary credit to land parcels that have building difficulties.

2.5 Advances in management and science

Forests under pressure

Our urban forests are under pressure as never before. Natural disasters like hurricanes leave dead and damaged trees in their wake, and many communities lack the capacity and resources for restoration. Moreover, wildfires ravage our forested natural areas, leaving them so damaged that they are challenged to regrow on their own (Davis *et al.*, 2023). In addition, land developers convert and fragment forested landscapes for new housing, often destroying valuable habitat and contributing to declining biodiversity. Furthermore, climate change alters the growing conditions, making some places hotter and drier while flooding root systems in others. And finally, adding to the vulnerability of urban forests, invasive insects and diseases leave broad swaths of hazardous dead trees across our cities and invasive plants crowd out our native trees.

The emerald ash borer (EAB; *Agrilus planipennis*) gives one poignant example of the devastation that invasive insects can have on our urban forests and of the impact on the people who rely on them. EAB most likely entered North America in the early- to mid-1990s, carried over from its native Asia in shipping containers. It was not observed in forests of the United States until 2002, when scientists found it on Detroit's ash trees. It was **observed in Windsor, Ontario** that same year. Since then, **EAB has continued to spread rapidly** across the United States of America, and is now found in the Midwest, the northeast, the south, and as far west as Oregon and in five Canadian provinces. Hundreds of millions of ash trees across the continent have fallen to the pest. EAB continues to impact the economy across the rural to urban gradient, costing forest managers, nursery owners, governmental organizations, and private landowners hundreds of millions of dollars.

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[3] Redlining is a discriminatory practice in which services are withheld from potential customers who reside in neighbourhoods classified as "hazardous" to investment; these neighbourhoods have significant numbers of racial and ethnic minorities, and low-income residents.

Sadly, the RSB is only one of many **pests and diseases threatening North American forests** today. For example, the spongy moth (*Lymantria dispar)* continues to threaten oak forests in 19 states, the District of Columbia, and neighbouring parts of eastern Canada. **Sudden oak death**, caused by a mold pathogen called *Phytophthora ramorum*, is killing oak trees in California and Oregon, and impacts an additional 75 species. In addition, the hemlock woolly adelgid (*Adelges tsugae*), an insect native to East Asia, remains unchecked by native predators, weakens hemlock and spruce trees, and is devastating populations of Eastern hemlock in suburban and rural communities.

In Mexico, urban forests face similar challenges with **multiple pests and diseases** that put trees at risk. In addition, urban forests are often threatened by changes in land use for urban development or by informal appropriation of land by vulnerable groups. The lack of planning and regulations for housing construction and tree care, as well as of municipal budgets and staff to monitor permits and compliance with the laws in place are challenges that threaten the future of urban forests in Mexico.

New methods and best practices

Today, forest managers work to detect stressors early in order to protect the resilience and sustainability of our urban forests. To this end, they combine collaborative techniques with emerging technologies. For example, tools such as ***Healthy Trees, Healthy Cities***, developed in partnership with The Nature Conservancy, the USDA Forest Service and Georgia Tech University, enable staff and community volunteers to gather observational, early detection data on urban trees. The tool can be downloaded onto a smartphone, removing the barrier of requiring expensive specialized equipment.

In addition, researchers at the USDA Forest Service, the New Jersey Institute of Technology, and the College of Saint Rose developed a model for **early detection of ash trees infested by EAB**. The model combines a map of a city's ash trees with multiple health categories that allow for a more accurate forecast of ash health when compared with previous models. When combined with community surveillance for early signs of infestation, like looking for increased woodpecker activity as the birds hunt for EAB grubs, models like this can help a city prepare in advance for an EAB infestation and treat trees with insecticide in time to prolong their lives.

In the eastern United States of America, ***Urban Forest Strike Teams***, composed of ISA Certified Arborists from state forestry agencies across the region, are deployed to assess tree risk and damage in order to help mitigate the effects of disasters to a community's tree canopy. Team members gather information on mobile devices and equip municipalities with the information they need for the Federal Emergency Management Agency's (FEMA) ***public assistance applications for debris removal***.

On-the-ground monitoring is time-intensive, and communities often lack the resources to monitor trees as frequently as necessary. The USDA Forest Service has developed protocols to support **long-term monitoring of tree growth** (Roman *et al*., 2019). The agency has also developed methods with community members **to collect and study moss samples in trees** (Kirkland, Jovan and Derrien, 2023) in order to map air quality in heavily polluted neighbourhoods. These more intensive methods can now be supplemented with **remote sensing technologies**, such as light detection and ranging (LiDAR) collected by unmanned aerial vehicles (drones), to detect early signs of stress in urban forests.

Since 2021, Reforestamos Mexico has promoted the **Environmental Detectives** initiative, through which company personnel, students and neighbourhood groups are trained to become "citizen scientists". Through the training they receive on the **iNaturalist** platform, they collect and input information on biodiversity and the condition of urban trees to inform decision-making.

Community co-design for resilient forests

Pressures on people and forests today are compounded by a long **history of systemic racism and disinvestment in communities of colour and poverty** (Locke *et al*., 2021). For example, in the 1930s, the federal Home Owner's Loan Corporation in the United States created maps that colour-coded neighbourhoods in 149 cities. These maps assigned grades to neighbourhoods to represent risk factors for residential mortgage lenders, and are often referred to as "redlining maps" because the highest risk areas were designated in red. These redlining maps effectively blocked people of colour from participation in the housing market and building generational wealth. As a consequence, this set the stage for the inequality we see in many cities in the United States today, including in tree canopy. An analysis of 37 metropolitan areas (Locke *et al.*, 2021) showed that neighbourhoods given an `A` rating in these redlining maps have almost double (43 percent) the tree canopy of neighbourhoods given a `D` rating (23 percent).

Urban forestry practitioners and related professions together research scientists are working in partnership with communities to **rectify past inequities and ensure equal access** (Carmichael and McDonough, 2018) to the benefits that our urban forests provide. To this end, they are **co-design urban forestry projects with impacted communities** (Johnson, Campbell and Svendsen, 2020), including planting and management activities. Practitioners are learning a great deal about **community co-design from tribal communities** and other disciplines in real time, including environmental justice, and diversity, equity and inclusion principles.

Examples of co-design strategies include those documented in the **Johnston Square neighbourhood of Baltimore**. The process consisted of the following:

- ✓ **co-developing** problem statements, objectives and power sharing strategies with community leaders;
- ✓ **cultivating** meaningful engagement opportunities for all stakeholders and recognizing that everyone is an expert based on their own lived experiences;
- ✓ **engaging** the practitioners as facilitators and capacity builders; sharing knowledge and tools with stakeholders; focusing on and elevating the voices of those directly impacted and building upon the strengths and resources within the community;
- ✓ **sustaining, healing and empowering** communities by addressing the cumulative impacts of disinvestment in **environmental justice communities**;
- ✓ **facilitating** collaborative partnerships and power sharing at all phases of the project;
- ✓ **working** towards sustainable, community-led and controlled outcomes through a cyclical and iterative process;
- ✓ **disseminating** knowledge and sharing results with all participants using diverse communication channels.

These types of co-design processes share power with communities, putting them in the driver seat, and ultimately help them to become more resilient to climate change, pests, disease and poverty. For example, in rural communities in Mexico, ***Plant With Purpose*** has used a community-led model to plan and execute reforestation projects, simultaneously addressing environmental degradation and extreme poverty. After years of persistent droughts, heavy rains and flash floods in many areas of Oaxaca, Mexico, which reduced crop yields and increased rural poverty, *Plant With Purpose*, with funding from the Arbor Day Foundation, is working with communities to plant drought-resistant trees and restore the soil, the water and the forests that people depend upon for their livelihoods. Community members are planting fruit trees on their individual plots in addition to organizing larger-scale efforts to plant native pine on surrounding communally managed hillsides. These efforts are helping farmers heal their degraded land and creating a better future for their families.

The City of Philadelphia developed its first-ever **urban forest strategic plan (Philly Tree Plan)**, proudly engaging more than 9 000 of its residents in a community-led process. Between 2008 and 2018, Philadelphia's urban forest shrunk by 6 percent, i.e. equivalent to 1.000 American football fields worth of tree canopy. However, the remaining tree canopy is not fairly distributed across the city, with some neighbourhoods having under 5 percent tree canopy, while others have 45 percent or more. The Philly Tree Plan is a response to these challenges; it is a 10-year strategic plan for the growth and care of the urban forest that puts people first, with three key values guiding the Plan: environmental justice, community engagement and sustainability. Therefore, the Philly Tree Plan aims to bring the benefits of trees to those communities that need them the most, and in the ways that support them the best. The plan describes many ways for residents to get involved, but sets no tree planting or canopy cover goals. Its focus is on the public health and job-related benefits of public investment.

New initiatives and research findings

Cities are **complex social–ecological systems** where elements are self-organized and interconnected, and have leverage points that can improve the system. To address the complex issues facing our forests today, cities are developing systems-based solutions that attract resources for sustaining green infrastructure, including trees, that deliver multiple positive outcomes.

The USDA Forest Service is working collaboratively with communities to model systems-based approaches to urban forestry and conservation. For example, the **New York City Urban Field Station** developed the **Stewardship Mapping and Assessment Project** (STEW-MAP), which is both a methodology and community organizing tool that helps collaborators understand who is engaging in urban stewardship across their community. This kind of understanding has helped to shed light on opportunities for novel collaboration. The tool has been piloted and is being applied in more than a dozen cities and mosaic landscapes around the world, including in Mexico. Recently, Tree Canada partnered with the Canadian Forest Service and the University of Toronto to lead a **pilot study** in the City of Toronto, Canada.

Guadalajara
La Ciudad

© City of Guadalajara, Mexico

© Photo courtesy of City of Guadalajara, Mexico

Caption: Guadalajara Nursery, Mexico

In another example, the **Baltimore Urban Field Station** collaborated with city leaders and non-profit groups to develop a framework for utilizing urban wood, known as the **Baltimore Wood Project**. The framework mapped the necessary components of a functioning urban wood economy and included workforce development for under-employed people and opportunities to enhance tree planting and maintenance budgets through partnerships with producers and consumers of urban wood products. In support of this framework, the USDA Forest Service funded business case studies to examine the economic value of wood and other benefits from the deconstruction of terraced houses, and from urban forestry activities more generally. Findings from these reports catalysed a USD 15 million programme from the State of Maryland to dismantle vacant row homes in Baltimore, and a nearly USD 1 million innovation loan from the city to support utilizing wood from urban forestry activities. This model is now being replicated and expanded in other metropolitan areas through a new national **Urban Wood Network** including transdisciplinary efforts focused on sustaining green spaces in cities.

Our shared concept of the role of forests in cities is also shifting. To many practitioners, urban forests have been synonymous with street trees, but today this definition has expanded to include trees on private lands and our forested natural areas as well. **Scientists at the USDA Forest Service** and the **Natural Areas Conservancy** are collaborating to identify and disseminate best practices for managing urban forest patches of wooded natural areas within cities, **adapting traditional silviculture to the assessment and management techniques in urban settings** (Piana, Pregitzer and Hallett, 2021). The Natural Areas Conservancy is disseminating the best practices via their **Forests in Cities** Resource Library, a collection of 17 cities across the United States of America that is expected to grow in the years ahead.

Forests are also being further integrated into buildings, creating opportunities to blur the lines between indoors and outdoors via biophilic designs. Biophilic design is an approach to architecture that seeks to connect building occupants more closely to nature. Biophilic designed buildings incorporate natural lighting and ventilation, natural landscape features and other elements for creating a more productive and healthier built environment for people.

Mass timber[4] continues to gain popularity around the world as a construction material, and often includes exposed wood elements in buildings. This type of construction that includes wood sourced in urban areas can also enhance the health of our overstocked, fire-prone rural forests through sustainable harvesting of smaller diameter wood. **Including plants and exposed wood in the built environment** can reduce stress and improve well-being for people (Fell, 2010). Therefore, combining exposed wood in buildings with robust urban forests and healing landscapes has the potential to enhance these mental health benefits in a sustainable way (USDA Forest Service, 2018).

Adaptation management of urban forests for climate change is an active area of science and practice. Collaborative efforts with local governments and non-profit groups are taking place for **tree improvement** in seed orchards and for **assisted migration** of tree species from the South to test plots in the North. Also, the new **Long-Term Ecological Research Program** has begun in the Minneapolis-St. Paul Metropolitan Area, bringing together more than a dozen research institutions to study how urban stressors affect the ecological structure and function of urban nature.

Recent advances in **urban forestry research** at the USDA Forest Service include the following:

- ✓ Well-managed trees and green infrastructure can buffer the negative impacts of a **changing climate and expanding urban footprint**.
- ✓ Trees, forests and green infrastructure can also improve **community health and well-being** and provide jobs that support economic growth.
- ✓ Understanding the status and trends in urban forest health and tree cover can inform and improve **management and protection** efforts.
- ✓ Stewardship of urban forests **strengthens civic capacity**, builds social cohesion, and supports the foundations of a thriving civil society.

In Canada, there are organizations and research institutions that are collaborating to conduct innovative research to improve urban forest management and practices by considering broader dialogues in social integration such as equity and creative interventions. Tree Canada's next **Canadian Urban Forest Conference** (October 2024) will focus on equity themes such as governance and community connectivity, environmental and social justice, and the various values and viewpoints of urban green spaces that impact and influence urban forest management, planning and practice.

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[4] Mass timber uses state-of-the-art technology to glue, nail or dowel wood products together in layers. The results are large structural panels, posts and beams.

2.6 New directions

A moment for accelerated growth

Working together with local communities, the region's UPF community of science and practice has the opportunity to realize the goals of planting the right trees in the right places, maintain the existing urban tree canopy, and grow more equitable, diverse and resilient urban forests for the future.

The **Inflation Reduction Act**, passed in 2022, includes billions of dollars to support equitable urban forests through federal agencies in the United States, including the **Federal Highway Administration**, the **Environmental Protection Agency** and the **USDA Forest Service**. These unprecedented funding levels offer the opportunity to leverage emerging technologies, systems-based solutions and best practices to address past inequity and current threats.

Many other federal government agencies and programmes have received climate mitigation funds through the Inflation Reduction Act and signed a **seminal agreement to collaborate** on leveraging each other's work to increase public access to nature in communities. This cross-government collaboration has the potential to transform the connectivity that residents have with natural infrastructure by cutting across lines of income and race in the United States.

The **Fourth National Climate Assessment** (NCA 2018) acknowledged that urban forests, open spaces and waterways provide multiple benefits, but many are under stress because of land-use change, invasive species and pollution. A new NCA initiative focused on **Natural Capital Accounting** (Baghdad *et al.*, 2021) will focus on the economic benefits of urban green space as a contributor to gross domestic product.

In the context of climate change, and recognizing the high mobility of people in the North American region, there is potential for regional cooperation to prevent or slow the spread of pests and diseases that threaten urban forests. New tools and technological advances that will be available online can generate community science strategies to detect pests and pathogens more rapidly.

Potential alliances

Discussions have been proposed to expand the successful **Alliance for Community Trees** across North America and use it to increase the number of Tree Cities of the world. This would include translating English materials into Spanish to promote the culture of urban forests in Mexico. In this way, the successes in the United States might be replicated at scale.

Through the **Commission for Environmental Cooperation**, there are opportunities for North American countries to collaborate in strategies to strengthen urban forests. An example could be to support Mexico, based on the lessons learned from the United States and Canada, to integrate a national policy on UPF with state/provincial and municipal governments, as well as promote multisectoral collaborations to protect and equitably expand urban and peri-urban forests.

treesNYC
One in a Million

© Photo courtesy of Phillip Rodbell, USDA Forest Service

Caption: New York City, New York – Planting the first tree of a million tree initiative.

New dialogues and networks

Over the past decade, there have been new dialogues emerging in urban and peri-urban forestry that advance ideas of social and ecological equity. One such dialogue is gender equity and women's leadership and the emergence of multiple networks, initiatives and research focusing on women in urban forestry. It is hoped that these dialogues result in greater coordination and more equitable actions and investments across sectors.

Examples include:

Policy and action planning: **Gender Equity in the Forest Sector**; Fem4Forests

Conferences/congresses: **Forests in Women's Hands**; **Women's Forest Congress**; and **Women in Natural Resource Sciences**

Events and activities: **Women in Arboriculture**; **Where Women Choose to Walk: Paths to Improving Cities and Nature** (international panel discussions); **Women Branching Out: A diversity of careers in arboriculture and urban forestry** (film)

Networks: **Beyond Trees Network: Women, Urban, Natural Resources**; **Women in Wood**

Industry training workshops (e.g. **Her City Toolbox** – United Nations)

Research includes:

Women in urban forestry and arboriculture: Experiences, barriers and strategies for leadership (Bardekjian *et al.*, 2019)

Healing experiences of middle-aged women through an urban forest therapy program (Lee *et al.*, 2019)

Arboriculture – a female perspective (Currell, 2016)

Addressing gender inequities in forest science and research (Macinnis-Ng and Zhao, 2022)

Conclusions

The journey to create more healthy, green communities in the North American region had humble beginnings. Through visionary and persistent leadership at universities and federal, state and local levels in government and non-profit organizations, and with private sector support, a vision for healthy urban forests and vibrant communities has taken hold and is thriving. New capacity and the next generation of leaders are developing rapidly at all scales, which promise to result in the protection and expansion of trees, forests and green spaces that are climate resilient and equitably distributed for the benefit of all residents.

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3

URBAN FORESTS: A PERSPECTIVE FROM THE ASIA-PACIFIC REGION

"Guiding urban forestry for resilient, informed communities"

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URBAN FORESTS: A PERSPECTIVE FROM THE ASIA-PACIFIC REGION

3.1 Population growth, economic growth and urbanization

The Asia–Pacific region represents less than 25 percent of the global land area but is home to more than 60 percent of the world's population, as estimated in the Third Asia-Pacific Forest Sector Outlook Study (APFSOS III) (FAO, 2019), i.e. around 4.3 billion people (UNDESA, 2022). Due to rapid urbanization over the last few decades, more than half of the people in the region now live in urban centres – estimated at 2.2 billion (UN-HABITAT, 2022). This transition to an urban-dominated population is expected to continue so that by 2050, another 1.2 billion people will be living in the towns and cities of the Asia–Pacific region. Therefore, of the predicted 9.7 billion global population in 2050, approximately 3.6 billion (i.e. more than one-third) will be living in urban centres of Asia–Pacific countries (UN- HABITAT, 2022).

The Asia–Pacific region is also experiencing the most rapid economic development globally, led by China and India. The shift to an urbanized population is also bringing with it a rapidly expanding, educated and wealthy middle class. In combination, this situation changes the expectations and demands put upon these urban landscapes, neighbourhoods, green spaces and urban forests. In addition, the countries in the Asia–Pacific region are very diverse in socioeconomic status, religious and cultural backgrounds, and face different geographical and climate-related challenges. However, the demand for urban green spaces and urban forests are evident and universal, but the capacity for urban planning remains limited in many countries, often leading to disorganized and dense urban development (FAO, 2019).

Table 1. The countries and subregions that make up the Asia–Pacific region.

SUBREGION	COUNTRIES
Oceania	**Australia**, Fiji, Kiribati, **New Zealand**, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu
East Asia	**China**, Democratic People's Republic of Korea, Japan, Mongolia, Republic of Korea
South Asia	Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka
South Asia	Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka
Southeast Asia	Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, **Malaysia**, Myanmar, Philippines, **Singapore**, Thailand, Timor-Leste, Viet Nam

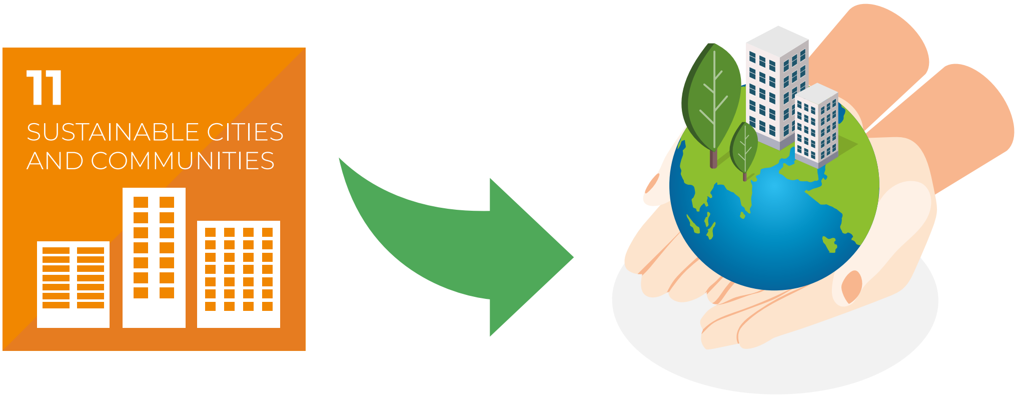
This chapter on the state of urban forest in the Asia–Pacific region showcases on five countries from three subregions:

- **OCEANIA** > Australia, New Zealand
- **EAST ASIA** > China
- **SOUTHEAST ASIA** > Malaysia, Singapore

3.2 Sustainable development and sustainable urbanization

In 2015, under the guidance of the United Nations, 17 Sustainable Development Goals (**SDGs**) were introduced as part of the 2030 Agenda for Sustainable Development, representing a universal call to action that brought together nations worldwide in a collective global partnership. Of particular relevance to urban centres is SDG 11 – "Make cities and human settlements inclusive, safe, resilient and sustainable". As more than one-third of the world's urban population are predicted to be in Asia–Pacific cities, the importance of sustainable urbanization is evident for this region.

In the twentieth century, urbanization as a global development issue was not high on the international agenda. The first the first United Nations Conference on Human Settlements (also known as Habitat 1) took place in 1976 in Vancouver, Canada. Habitat I also laid the foundations for the establishment, in 1978, of the United Nations Human Settlements Programme, or UN-Habitat. However, these early sustainable urban development programmes received little support until UN-Habitat came into being as a full United Nations programme in 2002. From this point onwards, the important connection between sustainable development and urbanization has grown in recognition and priority. The New Urban Agenda (NUA) was adopted at the UN-Habitat III Assembly in 2016, setting key principles for the planning, construction, development and management of urban centres, and highlighting linkages between sustainable urbanization and job creation, livelihood opportunities and improved quality of life, and it insisted on incorporating all of these sectors into every urban development or renewal policy and strategy.



3.3 Urban forests and sustainable urbanization

The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) built upon the New Urban Agenda with its own 'Future of Asian and Pacific Cities' report (ESCAP, 2019), which recommends policy pathways and strategies for the region's sustainable urban future. These pathways were structured around four main themes:

a) Urban planning
b) Urban resilience
c) Smart cities
d) Urban finance

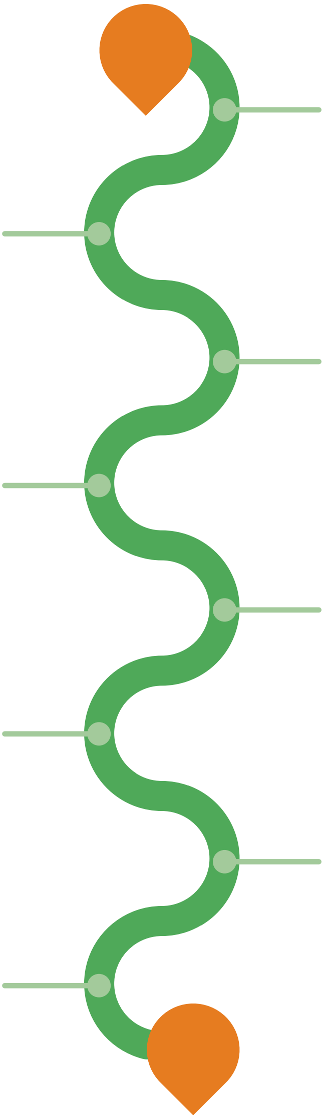
Urban greening and the urban forest play a central role in the first two themes – integrating urban blue and green infrastructure into all future development planning processes, and through the improved environmental and community resilience that nature-based solutions, such as urban forests, can provide.

For urban forests in the Asia–Pacific region more specifically, FAO has been hosting regional fora so that practitioners, researchers and policy and decision-makers can meet, share ideas and set common collective objectives. The inaugural Asia-Pacific Urban Forestry Meeting (APUFM) in Zhuhai, China in 2016 was followed by the 2nd APUFM in the Republic of Korea the following year, in which the Seoul Action plan was established and on which this chapter is based. The 3rd APUFM, held in Bangkok in 2021, provided a continued platform for furthered discussions and sought to identify concrete actions to support the implementation of the Seoul Action Plan. This plan aims to:

- expand awareness of the benefits that urban forests and trees provide;
- sustain and foster urban forest growth for community resilience;
- support decision-makers in planning, designing and managing their green capital; and
- provide guidance on actions towards sustainable urban development.

There are eight clear goals, each with stated actions and outcomes that members of the Asia–Pacific region should seek to achieve in the coming decades.

The eight goals



GREENER CITIES
increased urban tree canopy cover and green space area

CLEANER CITIES
urban air quality strategies recognize urban forest benefits and targets

COOLER CITIES
urban forests for urban heat island (UHI) reduction and human thermal comfort

HEALTHIER CITIES
urban forest role in human health and well-being and access for all to green spaces

MORE INCLUSIVE CITIES
equitable distribution of urban forests and recognized sociocultural significance

MORE BIODIVERSE CITIES
urban forest connectivity and diversity for nature conservation

WEALTHIER CITIES
valuing the ecosystem services in Asia–Pacific cities and funding/ planning to promote green businesses and green jobs

SAFER CITIES
urban forest role in adapting cities to climate change and disaster events, thus increasing community resilience

10 YEARS

The following case studies from five Asia–Pacific countries provide examples of progress towards these goals through some of the stated actions. There are also examples of barriers or hurdles to achieving some of these goals, but invariably, some cities or countries are able to provide inspiration and a template for progress and success.

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3.4 Urban forest canopy cover change in Australia and New Zealand

Stephen Livesley, Faculty of Science, The University of Melbourne

Cities in Australia and New Zealand have actively embraced the concept of the urban forest – recognizing that urban forests provide many important ecosystem services, as well as biodiversity habitat and support to human health and well-being. Many cities or local governments have developed urban forest strategies to strengthen the role of urban trees and other green infrastructure in climate change adaptation and improved liveability (City of Melbourne, 2011; City of Sydney, 2023). A common theme in these strategy documents has been the setting of targets to increase urban tree canopy cover by a certain year. For example, the City of Sydney has a target of 27 percent by 2050, up from 15.5 percent in 2008. Similarly, the City of Melbourne has set a target of 40 percent urban tree canopy cover by 2040 on public land, up from 22 percent in 2012. These targets clearly align with Goal 1, 'Greener cities', from the Seoul Action Plan.

Common motivations for local governments to develop urban forest strategies and to set targets include: urban cooling and heat wave mitigation; biodiversity habitat provision; and human well-being and connecting with nature (Gulsrud, Hertzog and Shears, 2018; Hartigan *et al*., 2021). Another key driver is the very real concern that urban tree canopy cover has decreased in many Australian and New Zealand cities. The concern is that urban tree canopy cover continues to decrease despite drafting these urban forest strategies, despite setting these ambitious targets, and despite the comprehensive tree planting plans put in place (Hurley *et al*., 2019). In just four years, between 2014 and 2018, Greater Melbourne experienced a decrease in canopy cover from 13.6 to 13.3 percent (-0.3 percent). This may not seem significant, but when Greater Melbourne starts from less than 14 percent canopy cover, it is clear that this rate of decrease cannot be sustained for many years. Interestingly, the region of Greater Melbourne with the greatest tree canopy cover experienced the greatest decrease, i.e. 2.8 percent in just four years (Hurley *et al*., 2019). It is concerning that is that this phenomenon is being repeated in city after city throughout Australia and New Zealand.

In New South Wales, in just seven years (2013–2020), the City of Ryde observed a decrease in urban tree canopy cover from 40 percent to 33 percent (Hurley *et al*., 2020), mainly from private tree removals. Likewise, in Christchurch, New Zealand, aerial imagery and LiDAR analysis were used to detect a small decline (-0.5 percent) in canopy cover between 2011 and 2015, where it was noted that the neighbourhoods experiencing redevelopment and infill showed significant canopy cover decreases (Guo *et al*., 2019). Similarly, in Auckland, the capital of New Zealand, a recent study indicated no net change in city-wide canopy cover over a five-year period, although some neighbourhoods experienced significant decreases of up to -5 percent, while others experienced significant increases of up to +9 percent (Golubiewski *et al*., 2020).

There are also urban forest success stories in some Australian and New Zealand cities that can provide inspiration and a template for other cities experiencing canopy cover decline. The City of Sydney, for example, has made great progress by reaching 20 percent canopy cover in 2023. This gain in canopy cover has been achieved through a combination of planning controls that protect large trees and planting initiatives prioritizing locations that can support large trees. In South Australia, the City of Unley has employed an innovative and smart-city approach to remotely monitor and report on green space and tree canopy cover of each individual private property (Box 1). By applying such an approach, it is clear that tree canopy cover change can be a shared responsibility for all of us.

The City of Melbourne recognizes that most of the land and buildings in the city are privately owned, and in response has developed the Green Factor tool to ensure that more green cover is incorporated into any new building developments (Bush *et al*., 2021). Finally, on the western edge of Greater Melbourne, the City of Melton has undertaken a bold move and mandated that engineered passive irrigation systems must be installed with every urban street tree in new developments so as to direct runoff water to them and thus provide greater growth and drought resilience. These urban forest success stories demonstrate that cities in Australia and New Zealand can stop the loss of urban tree canopy cover through innovative policies and planning regulations that protect urban trees on both public and private lands (Clark, Ordóñez and Livesley, 2020; Croeser *et al*., 2020) while encouraging more green cover and tree planting as the cities are redeveloped through infill and densification.

Innovative monitoring and reporting in the City of Unley, South Australia

Eighty percent of the City of Unley 8South Australia) is private property and experienced a long-term decline in tree canopy cover, from 34 percent in 1979 to 22 percent in 2017, and decided to act. Unley has partnered with a local remote-sensing data company to develop the MyCanopy[1*] web-based application. The MyCanopy app allows homeowners to search for their (or any) residential address in Unley in order to see how the tree canopy on that property has changed over time. The remotely-sensed data behind MyCanopy can track tree growth (crown expansion), new tree planting, and most importantly – tree removal (Image 1).

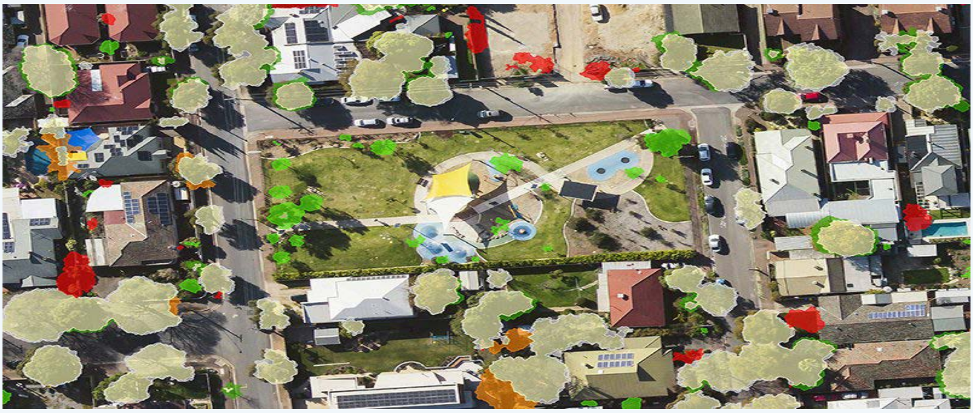

Image 1. Private residential properties and streetscapes surrounding the new Katherine Street Park in the City of Unley showing new (green) canopy growth as well as some loss (red) of trees.
(Source: Aerometrex Pty Ltd)

Furthermore, the City of Unley aims to provide personalized, individual property reports as part of the annual rates payment letter, enabling a small rates discount for a no net change or increase in tree cover and an effective rates penalty for any decrease. The objective is to make residents realize that we are all responsible for the greenness of our neighbourhoods, and the benefits are so important that the local government is prepared to provide financial incentives to retain or increase tree canopy cover on private residential properties.

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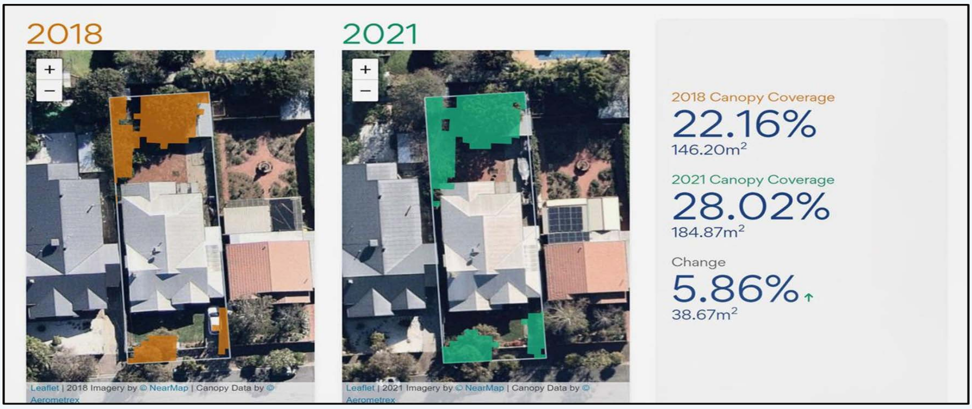
[1] The City of Unley's Digital Urban Forest webpage: https://www.unley.sa.gov.au/Smart-Unley/Digital-urban-forest


2018
2021
+
−
Leaflet | 2018 Imagery by © NearMap | Canopy Data by © Aerometrex
Leaflet | 2021 Imagery by © NearMap | Canopy Data by © Aerometrex

2018 Canopy Coverage
22.16%
146.20m²

2021 Canopy Coverage
28.02%
184.87m²

Change
5.86% ↑
38.67m²

Image 2. A personalized private property report on canopy cover change in Unley (Source: City of Unley, South Australia)

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3.5 Urban forests for native biodiversity in Aotearoa – New Zealand

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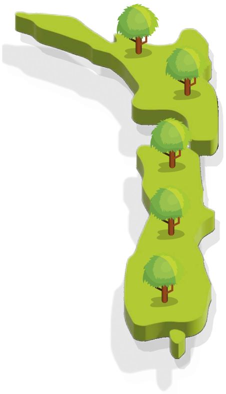

New Zealand has undergone rapid deforestation over the relatively short timespan after human colonization. Aotearoa (New Zealand) was initially populated by Polynesian peoples, largely the indigenous Māori, in the thirteenth century. However, major land modification did not begin until later in the sixteenth century following European settlement. Since then, the formerly lush, native forest cover of this rainy, temperate land has dropped to about a quarter of its initial extent due to land conversion for pastoral agriculture. Concurrent with this forest cover loss, urbanization has increased rapidly so that today almost 86 percent of New Zealanders live in cities. This recent swing towards urban living is resulting in a national identity shift from farming to city life and an emphasis on greening cities. The last few decades have seen an uptick in interest, policies and funding to support more than greening for ecosystem service provisioning, particularly for restoring native forest biodiversity. This aligns strongly with Goal 6 'More biodiverse cities' in The Seoul Action Plan. There is ample space available for restoring biodiversity (flora and fauna) among the hard engineered surfaces of New Zealand cities.

Some of this urban forest restoration focus is top-down from the central government. Supportive policies, such as the *National Policy Statement for Indigenous Biodiversity,*[2] and tree planting funding programmes such as *One Billion Trees*[3] (NZD 68 million, Te Uru Rākau – New Zealand Forest Service) and the COVID-19 scheme *Jobs for Nature*[4] (NZD 1.2 billion, Ministry for the Environment – Manatū Mō Te Taiao). There is also a growing emphasis on honouring an equitable governing relationship between the Indigenous Māori leaders (tangata whēnua, people of the land) and the European Government ('The Crown'). Te taiao (the natural world) is an underpinning element of the Māori worldview, and therefore increases in Māori-led government action also fundamentally support restoration of urban forest ecosystems and people's relationships with them (Hall *et al.*, 2021). These government policies clearly align with Goal 5, 'More equitable cities', as stated in the Seoul Action Plan.

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[2] https://environment.govt.nz/acts-and-regulations/national-policy-statements/proposed-nps-indigenous-biodiversity/

3 https://www.mpi.govt.nz/forestry/funding-tree-planting-research/one-billion-trees-programme/

[4] https://environment.govt.nz/what-government-is-doing/areas-of-work/jobs-for-nature/

However, urban forest restoration work more often originates from the bottom-up approach, i.e. through local community groups, Iwi (indigenous tribal) direction using indigenous knowledge, or philanthropic funding. There is a broad spectrum of urban forest care across the country, although in Hamilton (Box 2) we present a best practice case study that demonstrates how a very biodiversity-degraded city can be turned around.

Restoring and conserving native forest in Kirikiriroa (Hamilton)

Kirikiriroa–Hamilton is a small city about 170 000 people and has only roughly 2 percent of its indigenous ecosystem cover remaining. However, Hamilton has gone through a although shift over the past 25 years by embracing biodiversity and urban forest restoration actions to reconstruct entire ecosystems (Wallace and Clarkson, 2019). There is currently a network of community groups that work on pockets of land to restore biodiversity in the gully and park systems, volunteering massive amounts of time and relying on small city council grants and other funding sources to persist. The Hamilton City Council also contributes to these efforts through projects like *Waiwhakareke Natural Heritage Park*[5] and *the Nature in the City strategy*[6] strategy (2021). Waiwhakareke Natural Heritage Park is a remarkable flagship project where 65 ha of native forest are being reconstructed from scratch on former pastureland in an urban setting. The park planting and care is managed using a mixed model of city council and community inputs, and has followed a scientific restoration ecology framework since 2004 (Image 3). The *Nature in the City* strategy's goal is to increase native vegetation cover from 2 percent to 10 percent by 2050, with an initial 10-year tranche of funding of NZD 29 million. There is also support from the local University of Waikato and the urban forest restoration research programmes such as *People, Cities & Nature.*[7]

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[5] https://www.visithamilton.co.nz/see-and-do/parks/waiwhakareke-natural-heritage-park

[6] https://hamilton.govt.nz/strategies-plans-and-projects/projects/nature-in-the-city/

[7] https://www.peoplecitiesnature.co.nz/

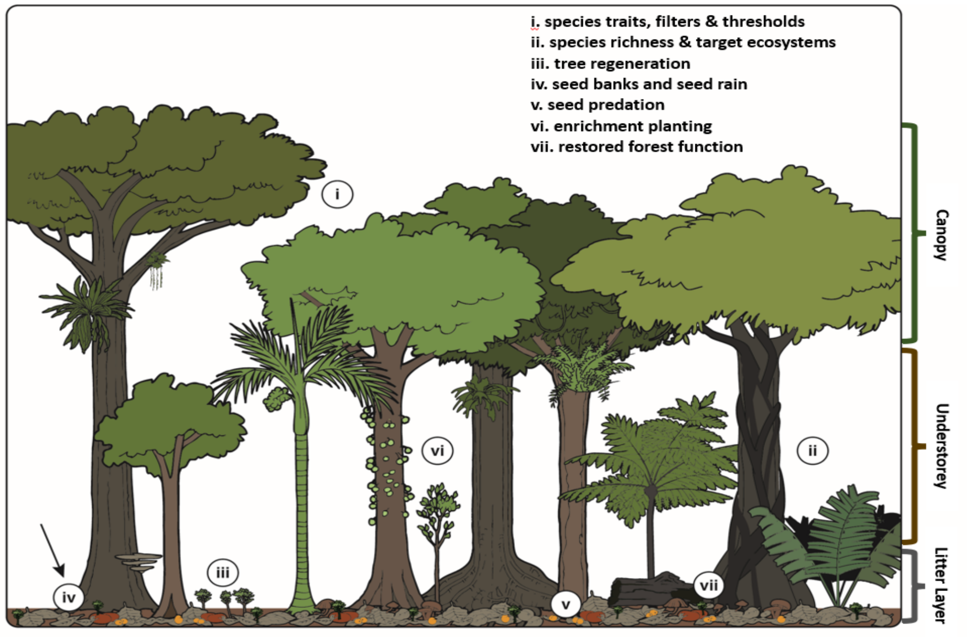
i. species traits, filters & thresholds
ii. species richness & target ecosystems
iii. tree regeneration
iv. seed banks and seed rain
v. seed predation
vi. enrichment planting
vii. restored forest function
i
vi
ii
iii
iv
v
vii
Canopy
Understorey
Litter Layer

Image 3. Best practice restoration of urban forest in Waiwhakereke Natural Heritage Park and Kirikiriroa (Hamilton).
Note: this generally follows ecological principles with an aim to recover many aspects of forest ecosystems and provide maximum habitat for biodiversity. Among other aspects, this restoration framework includes awareness of the larger landscape context, creation of self-perpetuating forests through successful reproduction and recruitment, and provision of ecological functions (i–vii inset).

As a result of this forest habitat restoration, and in tandem with introduced predator control, re-colonization by some native animals has occurred (Photo 1). For example, through the *Hamilton Halo*[8] project, the population of the endemic and iconic bird, the tūi (*Prosthemadera novaeseelandiae*), increased 25-fold between 2004 and 2019. The tūi is now the most commonly sighted native bird in Hamilton. Similarly, there is *Project Echo,*[9] which focuses on protecting one of Aotearoa New Zealand's two native mammals, *pekapeka-tou-roa* (the long-tailed bat; *Chalinolobus tuberculatus*). This is an endangered species that relies on large trees for habitat, hence actions to conserve mature urban forests are crucial for supporting these native mammals in New Zealand cities.

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[8] https://www.sciencelearn.org.nz/resources/1167-hamilton-halo-bringing-tui-back-to-hamilton-city

[9] https://goeco.org.nz/portfolio/project-echo/

©Joe Dillon

Photo 1. *Urban forest restoration in Kirikiriroa Hamilton welcomes the iconic Tūi and the long-tailed bat*
Note: "Build it and they will come". In some cases, this really has worked! As a result of urban forest restoration and conservation in Kirikiriroa–Hamilton, the iconic and endemic bird, the tūi (Prosthemadera novaeseelandiae, *left image*) *and pekapeka-tou-roa (long-tailed bat;* Chalinolobus tuberculatus, *right image*) are at home in the city.

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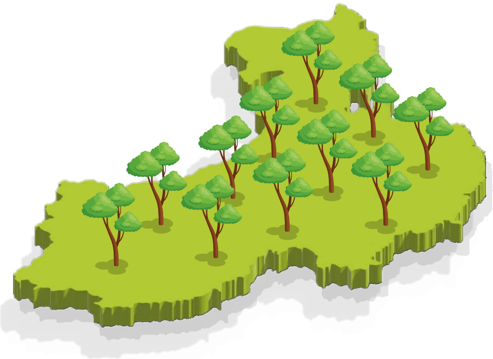
Wallace, K.J. & Clarkson, B.D. 2019. Urban forest restoration ecology: a review from Hamilton, New Zealand. *Journal of the Royal Society of New Zealand*, 49(3): 347–369.

3.6 China: 30 years of urban forest development

Wendy Y. Chen,[10] *Cheng Wang,*[11] *Jiali Jin*[12]



Since the convening of the first symposium on urban forests in Tianjin (northern China) in 1992, this innovative concept has been fully embraced and widely promoted as a key strategic priority nationally. The urban forest policy agenda in China aims to achieve landscape connectivity between urban and peri-urban settings to improve ecological stability, functionality and human well-being in the context of unprecedented urbanization. According to the latest statistical report (China City Statistical Yearbook, 2021), the gross area of urban forests (covering all greenspaces in urban and peri-urban areas) has increased significantly, from about 0.25 million ha in 1990 to 2.6 million ha in 2021 across 285 cities. Perhaps most importantly, from a human perspective, the greenspace area available per urban resident has increased from only 7.59 m^2 to 44.35 m^2 during the same period of time.

To enable such a tremendous expansion of urban forest area, a series of statutory instruments and non-statutory campaigns have been implemented. These initiatives encompass enhancing green spaces (landscape greening) in urbanized areas and planting new forests or restoring previously deforested areas (afforestation/reforestation) in peri-urban areas (Shen, 2023). In the 1990s, landscape beautification for enhancing natural aesthetics and recreational benefits was emphasized. This was supported by the Regulations on Urban Greening enacted in 1992, which stated that the green coverage ratio in new urban and peri-urban areas should not be less than 30 percent, while in old urban renewal areas, it should not be less than 25 percent, signifying a clear focus on constructing greener and more beautiful cities.

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[10] Department of Geography, The University of Hong Kong.

[11] Ibid.

[12] Urban Forest Research Center, The National Forestry and Grassland Administration of China.

In the 2000s, the emphasis changed to how urban forests in China could act as a countermeasure to various environmental stresses. The multiple environmental benefits of urban forests were highlighted, including air pollutant removal, urban heat island (UHI) mitigation, soil erosion control and surface water logging reduction. Since the 2010s, an integration of environmental, economic and social well-being benefits afforded by urban forests has been promoted in China. In addition to environmental benefits, themes such as ecological resilience, public health, social cohesion, tourism and urban branding have entered into the expanding domain of urban forests facilitated by the adoption of ecological civilization as a new development paradigm. A transformation is in progress from environmentally-polluted, ecologically deteriorated and socially segregated Chinese cities into vibrant, resilient, attractive, healthy and liveable hubs for the increasingly urbanized population.

National Forest City and the National Forest-City Cluster

Among notable achievements made in the last three decades, the most influential one is a nationwide campaign, the Program of the National Forest City that started in 2004. This programme was extended into the National Forest-City Cluster programme in 2016, and was elevated into the Forestry Law of the People's Republic of China since July 2020.[13]

The Program of the National Forest City was launched, with an overarching aim to "let forests enter into the city and let the city embrace forests". The Program conveys a clear notion that urban forests play key roles in: protecting/restoring urban and peri-urban ecological conditions; ameliorating environmental quality; improving social well-being; enhancing a city's image and competitiveness; and promoting urban and rural economic integration and development. In 2007, the National Forest City Evaluation Index was issued, covering a wide range of indicators focusing on both the quantity and the quality of urban forests. These indicators include: forest–urban greenspace coverage (Greener Cities); park area per capita attracting more physical activities and healthy lifestyles (Healthier Cities); road greening to help remove air pollutants (Cleaner Cities); riverine and waterfront greening to help control urban flooding (Safer Cities); tree species richness (More Biodiverse Cities); public participation and satisfaction; public education about urban forests and relevant ecological and environmental culture (More Inclusive Cities); and green industry (Wealthier Cities). A clear alignment is observed between China's Forest City programme and the urban forest development goals advocated by FAO in the Seoul Action Plan and the United Nations Sustainable Development Goals.

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[13] Forest Law of the People's Republic of China Promulgation Date, promulgated on 28 December 2019. https://www.atibt.org/wp-content/uploads/2020/01/China-Forest-Law-Amendment-2020-20191228.pdf

1. Expanding forested coverage in urbanized areas, peri-urban areas, towns and villages.

2. Improving green–blue networks and ecological resilience via protecting forest stands and inter-city natural lands, and constructing ecological corridors, greenbelts and riparian forests.

Key objectives in the Strategic Development Planning of the National Forest City (2018–2025)

6. Improving tree maintenance and safeguarding forest resources, including forest fire monitoring and management, and pest control.

3. Upgrading the quality of urban forests via re-naturalizing forests, conserving heritage trees and diversifying floral species.

5. Maximizing urban forests' ecosystem services, including social, environmental and economic benefits.

4. Nurturing ecological culture via public education, social engagement, citizen science and information disclosure.

During the National Forest City[14] construction, an extended Program of the National Forest-City Cluster was proposed in 2016, emphasizing ecological connectivity, biodiversity conservation and climate change mitigation. This change in emphasis is clearly in step with Goal 4 ‘More biodiverse cities’, Goal 2 ‘Cooler cities’ and Goal 8 ‘Safer cities’ in the Seoul Action Plan. As of 2022, a total of 221 cities (including municipalities, prefecture cities, municipal districts, and counties) have won the accolade of the National Forest City. Six National Forest-City Clusters are under construction, including Beijing-Tianjin-Hebei, Yangtze River Delta, Pearl River Delta, Changsha-Zhuzhou-Xiangtan, Central Plains, and the Guanzhong-Tianshui Economic Area.

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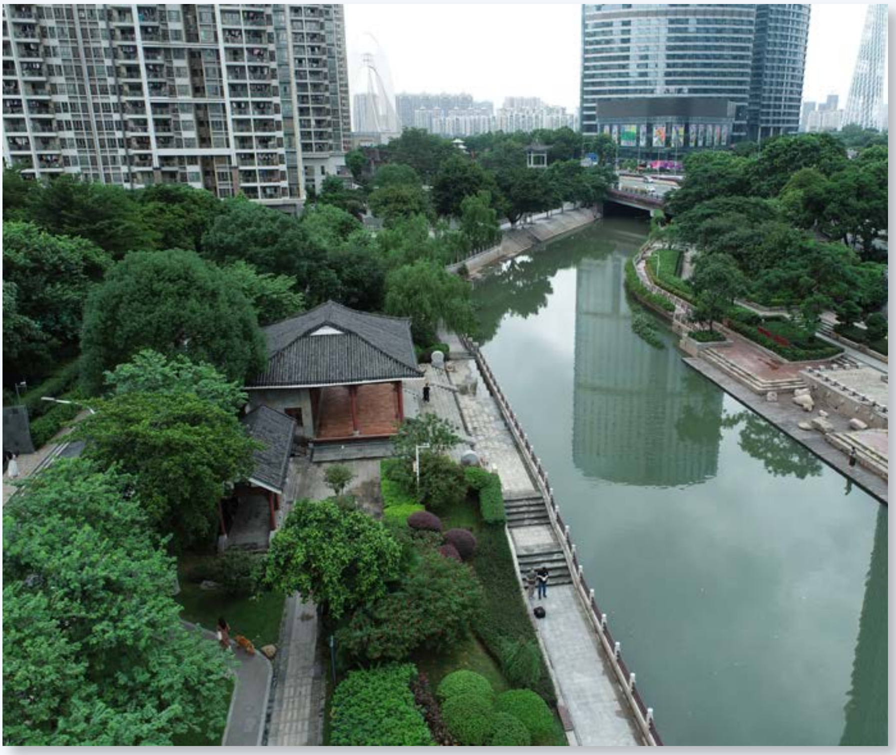
[14] https://www.forbes.com/sites/trevornace/2017/06/30/chinas-new-forest-city-will-make-you-rethink-urban-cities/?sh=6c06d078dabd

Guangzhou’s integrated greenways and blueways

While traditionally focusing on vegetation, the integration of blue components (various water bodies such as rivers, streams, ponds, lakes and wetlands) into urban forest construction has been increasingly emphasized. Both blue and green elements are key to the overall ecological stability and ecosystem service provision of cities. In the metropolitan area of Guangzhou (southern China), where the main watercourses and tributaries of the Pearl River run through the city’s peri-urban and urbanized regions, the construction and conservation of urban forest patches is thoroughly coordinated together with the revitalization of waterfront spaces, the creation of recreational trails, and the restoration of watercourses, aiming to make the “sky blue, water clear, mountain green, and landscape beautiful”. By the end of 2022, over 3 800 km of greenways and 1 000 km of blueways were built, connecting forest parks, waterbodies, historical villages, and cultural and heritage spots together in an extensive non-motorized network. The construction of integrated green and blue spaces helps to provide nature-based solutions to urban sustainability challenges. A wide range of ecosystem services has been emphasized, including natural aesthetics, biodiversity enrichment, air and water pollution remediation, urban flood regulation, climate mitigation, public health and natural education.

Key objectives updated in Guangzhou's Greenways and Blueways Development Plan (2019–2035)

1. Restoring habitat quality, ecological connectivity and biodiversity.
2. Minimizing urban flooding and waterlogging via nature-based facilities.
3. Preserving natural corridors to mitigate urban heat islands and to remove air pollutants.
4. Optimizing the spatial configuration of green–blue spaces to facilitate public recreational use.
5. Integrating ecological, economic and social functions of green–blue spaces for a harmonious human–nature relationship.



© Bureau of Forestry and Landscaping of Guangzhou Municipality

Photo 2. Green–blueway in Guangzhou.

According to the latest urban planning report published by Guangzhou municipal government, the aim is to construct 2 000 km of blueways and a total of 4 500 km of greenways by 2035. This would allow more that more than 90 percent of Guangzhou's citizens to live within 300 m of the nearest neighbourhood park and within 1 000 m of the nearest urban park. With these goals being achieved, a full range of different types of urban forest patches and blue water bodies can provide a healthy and resilient landscape for this large metropolis, where vibrant economic, social and cultural activities would be enabled and a harmonious human–nature relationship sustained.

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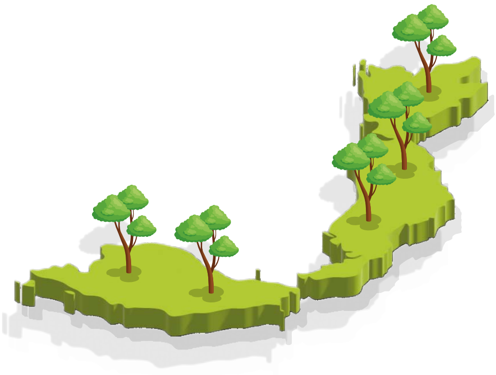
3.7 Urban forests for cooler cities in Malaysia

Ruzana Sanusi[15]



Malaysia is considered an urbanized developing nation. According to the Population and Housing Census of Malaysia 2020 (DOSM, 2022), the urban population in Malaysia increased from 70.9 percent in 2010 to 75.1 percent in 2020. Kuala Lumpur, the capital city of Malaysia, has the highest population density, with 8 157 persons per square kilometre. Putrajaya, the administrative city centre of Malaysia, has the highest population growth, with a 4.3 percent increase in just one year between 2021 and 2022.

Urbanization in Malaysia has brought significant changes in landscape cover and raised many urban climate issues. The urban heat island (UHI) effect is one of the prominent challenges with major implications for the health and well-being of urban citizens. In Kuala Lumpur, rapid land cover change and expansion have led to an increase in urban heating, and as a consequence, an UHI value of 8 °C (Wang *et al*., 2019). In addition, the administrative city of Putrajaya was planned and built based on a garden city concept where blue and green infrastructure was incorporated within the built environment. Nevertheless, Putrajaya still experiences high air temperatures and an UHI intensity within the range of 2°C to 3°C (Harun *et al*., 2022). Reduced vegetation in cities, limited shaded lanes in pedestrian walkways and the use of inappropriate building materials could all be determinative factors in the increase of the UHI in cities in Malaysia (Wong *et al*., 2017). The elevated temperatures in Malaysian cities can create discomfort among citizens, and during heat wave episodes, cause health problems for susceptible segments of the population, such as children and older people.

Selecting resilient tree species that can withstand urban stress, together with designs that support their growth, is crucial for ensuring tree health and securing a thriving urban forest for the future. Choosing ‘the right tree for the right place’ is a recommended strategy that can also optimize the long-term cooling benefits of urban trees. Selecting tree species with characteristics or traits that suit the conditions of the urban site means that they are more likely to provide good shade for people and the landscape for many years to come. In addition, selecting ‘the right tree species’ could also reduce unnecessary stress on these trees, and may reduce the need for pruning and other maintenance activities. Assessing and managing tree health with regard to pests and diseases should also be implemented as a good urban forest management strategy to help ensure that trees provide their optimum benefits and enhance their role in climate resilience. Many local councils in Malaysia now collaborate with certified arborists to ensure that urban trees are assessed for risks and health status, as well as helping match tree species to the site conditions. With these smarter urban forestry strategies and management being coordinated and implemented, cities in Malaysia can become more sustainable and liveable, and thrive in a changing world.

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Urban cooling through green initiatives in Kuala Lumpur and Putrajaya, Malaysia

Similar to other countries in the Global South, urban forestry is gaining prominence in Malaysia within the environmental, social, health and well-being, and economic context. As such, urban forest planning, management and actions are taken in line with sustainable urban development efforts. Kuala Lumpur has taken a step towards managing urban climate challenges by supporting a transformation into a more sustainable and liveable city. For instance, Kuala Lumpur aims to increase tree canopy coverage to 30 percent by 2030 (Kuala Lumpur City Hall, 2017). In addition, the ‘Kuala Lumpur Climate Action Plan 2050’ has been recently developed to serve as a guide to the local council and other stakeholders on how to make the city climate-resilient and carbon-neutral by 2050 (Kuala Lumpur City Hall, 2021). In this Climate Action Plan, in addition to flood and drought risks, heat risk is identified as the main climate threat to urban residents in Kuala Lumpur. An increase in the severity of these risks can exacerbate heat-related illnesses, air pollution, water quality, as well as damage to infrastructure and economic disruption. Climate-smart strategies in the Action Plan include green adaptive cities, energy-efficient and climate-proof buildings, and disaster management (Photo 3).

One action related to heat mitigation is the use of nature-based solutions to reduce urban heat island (UHI) impacts, such as:

- tree planting within the network of pedestrian priority routes;
- increased planting efforts to protect parks and sensitive biodiverse areas;
- green infrastructure to be embedded on buildings (i.e. vertical and horizontal greening); and
- awareness raising among citizens of heat-related heat-related health impacts and close monitoring of local weather in the heat management and response plan.

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Photo 3. Perdana Botanical Garden as part of the green initiatives in Kuala Lumpur

Unlike Kuala Lumpur, the city of Putrajaya comprises almost 40 percent green and blue spaces, including artificial lakes, wetlands and urban parks. Regardless of these green and blue features, the city still requires heat mitigation strategies due to UHI effects. In parallel with the city's aim for a dynamic and sustainable future, it is important for Putrajaya to implement the Putrajaya Structure Plan 2025 by developing from a garden city into a green city (Perbadanan Putrajaya, 2012). Moreover, through the Putrajaya Green City 2025, the targets are to reduce peak temperatures by 2 °C and decrease CO_2 emissions by 60 percent, which are aligned with the low carbon and temperature goals (Perbadanan Putrajaya, 2013). To mitigate UHI effects in Putrajaya, efforts currently being implemented include the preservation of green areas for carbon footprint reduction, urban greening, green connectivity improvement, rooftop and vertical greening, as well as other green initiatives so as to ensure a cooler city for the improvement of human thermal comfort and health.

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3.8 Singapore: six decades of urban greening

Tan Puay Yok, College of Design and Engineering, National University of Singapore

Singapore is widely known as a green city. This green status was achieved not by chance, but through concerted efforts in greenery planning and management that have been sustained over six decades. Active greening of the country started with a national tree planting programme in 1963. This in itself is remarkable as urban greening was initiated amid considerable socioeconomic and sociopolitical challenges that Singapore faced as a young, developing country in the early days of nationhood. To have devoted attention and financial resources to initiate an urban greening programme was an exceptionally far-sighted vision that has benefited Singapore tremendously. Despite having developed a high population density, Singapore has managed to maintain about 50 percent of the land area as vegetated (Yee *et al*., 2019).

The aims and strategies for greening Singapore have not remained static, but have evolved as the city-state copes with a changing socioenvironmental context and complexities of land-use planning and governance. Over 60 years, the urban greening journey was defined by a set of ideals and aspirations, which are captured in greening paradigms, initially from a “A Garden City”, then to “A City in a Garden”, and from 2021 onwards, to “**A City in Nature**”.

The City in Nature paradigm was conceived to ensure that a green environment in Singapore continues to contribute to the city’s liveability and sustainability for generations to come. It is underpinned by six strategies: (i) extending Singapore’s natural areas; (ii) intensifying natural areas in gardens and parks; (iii) introducing natural spaces into the urban matrix; (iv) strengthening connectivity among green spaces; (v) building science and technology and industry capacity; and (vi) fostering community stewardship (Er, 2021). This City in Nature approach clearly aligns with Goal 2 ‘Greener cities’, Goal 6 ‘More biodiverse cities’ and Goal 7 ‘Wealthier cities’ in the Seoul Action Plan. The aims of City in Nature are also aligned with the national plan to advance Singapore’s sustainability agenda, the Singapore Green Plan 2030, which sets targets and a roadmap to achieve net zero emissions by 2050. City in Nature is one of the five pillars that underpin this national plan.

Singapore's greening journey has attracted the attention of scholars (e.g. Tan, 2016, 2018; Er, 2021; Rowe and Hee, 2019; Siong, Gwee and Mak, 2012; Tan, Wang and Sia, 2013). These studies not only provide interesting perspectives through the lens of urban governance, political ecology and urban ecology, but also provide valuable lessons and insights that other cities can consider in their own urban greening endeavours. Of particular interest are the tangible and intangible benefits that urban greening has brought to Singapore. Broadly, one might categorize the benefits into two interlinked areas – benefits for the human population of Singapore, and benefits by conserving biodiversity in Singapore. Regarding the former, a green environment clearly benefits Singaporeans in terms of health, the promotion of social bonds, and the development of place identity and attachment. Much less information is available on the contributions of urban greening to urban biodiversity conservation in Singapore. As such, this case study highlights two relevant projects on this topic in the boxes below.

Urban greening and biodiversity conservation

Local ecological studies sounded alarms that massive deforestation in the early developmental history of Singapore and subsequent land cover change had led to catastrophic extinction of its flora and fauna (see Brook, Sodhi and Ng, 2003; Koh, Sodhi and Brook, 2004). Most recently, they have been surprising and encouraging results arising from biodiversity conservation efforts. National efforts in biodiversity conservation are encapsulated in the **Nature Conservation Masterplan**, which is complemented by the **National Biodiversity Strategy and Action Plan**. These two plans are both spatial and programmatic. Spatial plans safeguard biodiversity-rich habitats for conservation, identify additional green areas for habitat enhancement and restoration, and demarcate an island-wide ecological connectivity plan (Image 4) to guide long-term land use planning.[16] These plans focus efforts on research and monitoring, species recovery, ecological restoration and community engagement. Furthermore, together with a high level of greenery introduced into the urban matrix, they have provided a foundation to promote biodiversity conservation in Singapore. Some successes can be highlighted. The straw-headed bulbul (*Pycnonotus zeylanicus*) is a globally endangered bird on the International Union for Conservation of Nature (IUCN) Red List. Its population has experienced a drastic decline, largely due to its status as a prized songbird in the region. However, in Singapore, the population of straw-headed bulbuls has increased between 2000 and 2016 (Yong *et al*., 2018). A recent survey suggests that of the 600 to 1 700 mature birds left in the world, it is estimated that 200 to 500 are now found in Singapore (Emont, 2023). Singapore is a biodiversity stronghold and could be the "last straw for the species" (Yong *et al*., 2018).

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[16] Annex H. (A) NParks' Ecological Profiling Exercise. https://www.ura.gov.sg/-/media/Corporate/Media-Room/2022/Jun/pr22-25h.pdf

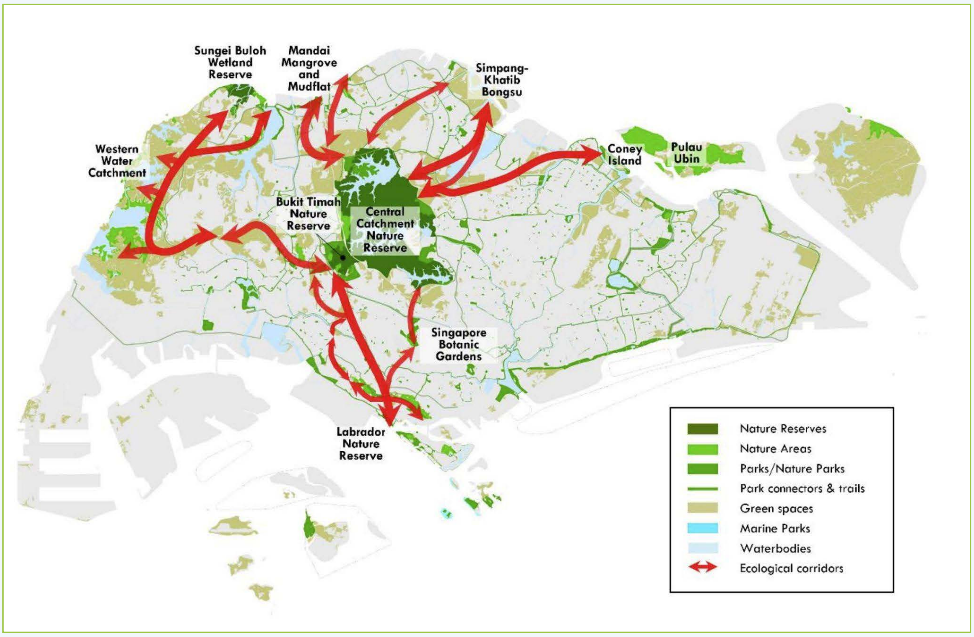
Sungei Buloh Wetland Reserve
Mandai Mangrove and Mudflat
Simpang-Khatib Bongsu
Western Water Catchment
Coney Island
Pulau Ubin
Bukit Timah Nature Reserve
Central Catchment Nature Reserve
Singapore Botanic Gardens
Labrador Nature Reserve
Nature Reserves
Nature Areas
Parks/Nature Parks
Park connectors & trails
Green spaces
Marine Parks
Waterbodies
Ecological corridors

Image 4. Island-wide ecological connections to connect biodiversity-rich habitats in Singapore (Image credit: National Parks Board, Singapore)

There are equally encouraging examples of the oriental pied hornbill (Cremades and Ng, 2012; Strange and O'Dempsey, 2022), smooth-coated otters (Khoo and Lee, 2020) and mouse-deer (Khoo *et al*., 2021), whose populations have grown in tandem with greening and conservation programmes. Importantly, as part of its Nature Conservation Masterplan, Singapore has a species recovery programme with currently 120 species in the programme. As work continues on these species, more successful conservation cases could emerge in the future. Remarkably, despite the massive loss of its original vegetation, Singapore continues to rediscover floral and faunal species that were thought to be extinct (Ngo *et al*., 2016). A multitude of factors could be involved in explaining the persistence of these species despite the environmental and urbanization disturbances. Regardless, the evidence from Singapore suggests that urban greening efforts have played a role and made a difference.

Nature Ways in Singapore

Street planting is an often neglected part of greening cities. However, Tan, Wang and Sia (2013) argued that street tree planting in Singapore plays an inordinately important role in creating a green ambience. In fact, Singapore's 'Green View Index' is the highest among high-density cities in **Treepedia**. Street planting in Singapore plays an important additional function – as linear ecological connectors, termed 'Nature Ways". Nature Ways promote the movement of fauna such as insects, birds and small mammals across the urban landscape and provide supplementary habitats if they are located close to biodiversity-rich areas.

The specific placement of Nature Ways in Singapore is planned through least-cost path modelling, which considers the resistance of different land cover types to the movement of faunal groups. Nature Ways are designed to consist of four layers of vegetation:

- an emergent layer formed by large forest trees such as Dipterocarps, which provide food for canopy-dwelling birds and nesting sites for birds of prey;
- a canopy layer comprising existing trees along the streets, that provide food and shelter for birds and butterflies;
- an understory layer formed by smaller fruit-bearing trees for birds and as host plants for butterflies;
- a shrub layer of flowering shrubs and ground cover that provide habitats and food for birds, butterflies and insects.

By 2021, 44 Nature Ways have been planted creating a total length of biodiversity habitat and connectivity of about 170 km. The target is to complete 300 km of Nature Ways by 2030.

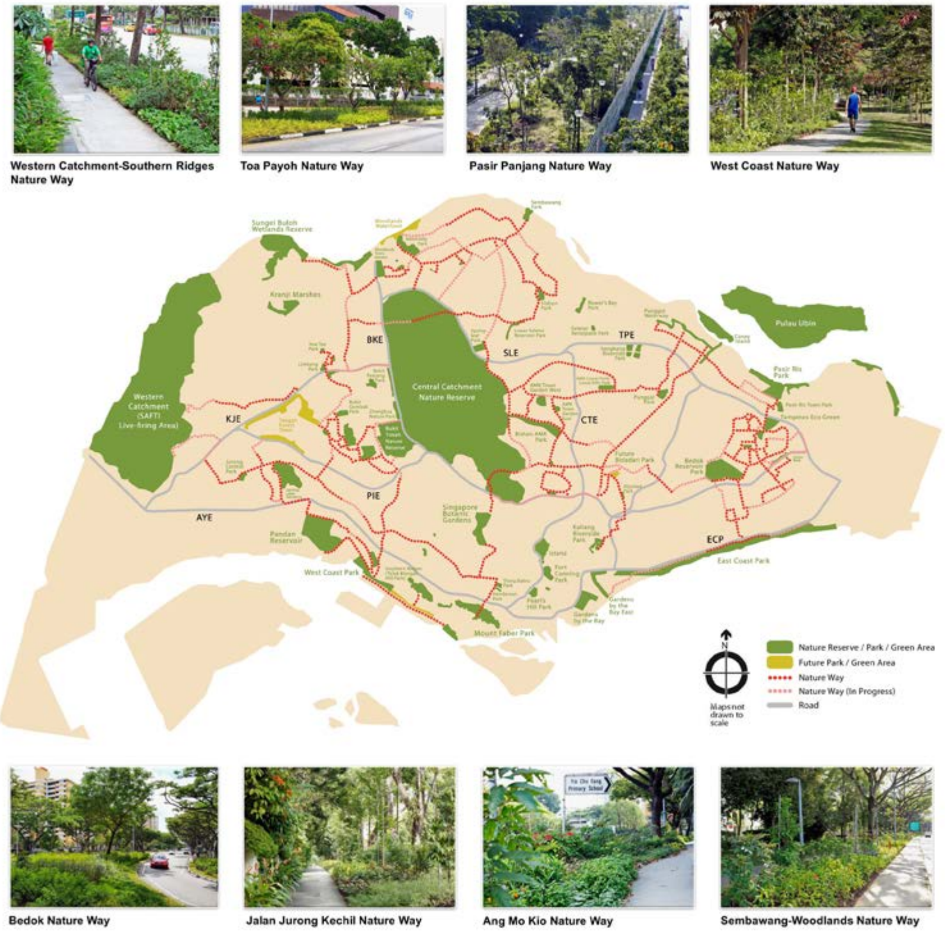
Western Catchment-Southern Ridges Nature Way
Toa Payoh Nature Way
Pasir Panjang Nature Way
West Coast Nature Way
Sungei Buloh Wetlands Reserve
Kranji Marshes
Western Catchment (SAFTI Live-firing Area)
Central Catchment Nature Reserve
Pulau Ubin
Pasir Ris Park
Singapore Botanic Gardens
Pandan Reservoir
West Coast Park
Mount Faber Park
East Coast Park
Bedok Reservoir Park
Fort Canning Park
Pearl's Hill Park
Gardens by the Bay East
Gardens by the Bay
Bishan-AMK Park
Kallang Riverside Park
Future Bidadari Park
BKE
SLE
TPE
KJE
CTE
PIE
AYE
ECP
N
Maps not drawn to scale
🟩 Nature Reserve / Park / Green Area
🟨 Future Park / Green Area
Nature Way
Nature Way (In Progress)
Road
Bedok Nature Way
Jalan Jurong Kechil Nature Way
Ang Mo Kio Nature Way
Sembawang-Woodlands Nature Way

Image 5. Nature Ways in Singapore 2023 (Image credit: National Parks Board, Singapore)

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3.9 The way forward for urban forests

There are still many challenges still exist for urban forests in the Asia–Pacific region, ranging from poor city governance to changing rainfall patterns, from inadequate budget support to new pest and pathogen outbreaks, and from private tree removals to a lack of community support. These many and varied challenges can only be tackled with innovative research, new ways of thinking, better funding, good and inclusive governance, and stronger regulatory and policy mechanisms. There remains a great need to maintain and increase urban forests in Asia–Pacific countries, whether this be Japan or New Zealand, Lao PDR or Fiji. Regardless of the socioeconomic status of the country, whether the country is a small island state or a continental country, urban forests have a central role to play in providing greater resilience to many climate change impacts, biodiversity loss, and human–nature interactions and well-being. This chapter provides some examples of how certain cities or countries have been able to successfully combine government and community initiatives, develop innovative regulatory policies, or perhaps apply ‘state-of-the-art’ monitoring techniques, all driving action towards achieving the goals set out in the Seoul Action Plan for urban forests.

The challenges facing urban forests are especially complex in countries experiencing, or having recently experienced, unplanned and rapid urbanization. However, many urban forests in developed countries also face challenges from urban densification resulting from high land values and urban population pressures. Without good planning regulations, and enforcement of these regulations, urban infilling and private development can similarly lead to urban forest decline. By sharing the stories of success in planning and managing urban forests in Asia–Pacific cities, we can find different suitable solutions that fit the urban forest context of that city, be it a climate context, a governance context or an economic context.

4

URBAN FORESTS: A PERSPECTIVE FROM EUROPE

“Increasing interest in spatial planning and urban design”

AUTHORS

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URBAN FORESTS: A PERSPECTIVE FROM EUROPE

4.1 Introduction

Urban forestry (UF) in Europe has grown significantly over the last 40 years, although its roots go back much further to include (peri-urban) city forest management, which in some cases date back many hundreds of years. When observing European towns and cities, the phenomenon of increasing urbanization appears to be an unstoppable trend. By 2050, it is forecast that 84 percent of the European population will be living within urban areas (UN DESA, 2019). In the context of urban growth, ensuring the sustainable maintenance and implementation of urban green areas is a key factor that contributes to the delivery of multifunctional benefits. Despite some significant aberrations such as the recent Plymouth tree felling in the United Kingdom,[1] municipalities are increasingly showing a strong willingness to combine urban densification with the demand for high-quality green space. These outcomes can be achieved through adopting new strategies and innovative approaches to project implementation. One approach is the '15-minute City Project', which envisions urban areas where all essential services are accessible within a fifteen-minute walk or bike ride, thereby reducing the need for long commutes and promoting local living. Another pivotal strategy is the '3-30-300 rule',[2] which states that every home should have a view of at least tree threes, every neighbourhood should maintain a minimum of 3' percent tree canopy cover, and every individual should be no more than 300 metres away from high-quality urban green spaces (Owuor, Whitehead and De Vreese, 2022).

Urban trees and urban forests in Europe are generally viewed as part of an urban area's 'green infrastructure', and diverse stakeholder groups, including companies, policymakers, voluntary associations and citizens are all involved with them to some extent. It must be stressed, however, that Europe is geographically and culturally a very diverse area, which is also reflected in the key issues and approaches adopted regarding urban forestry practices and governance. The authors have considered the following key themes within the different subregions of Europe (see Table 1 below):

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[1] https://www.bbc.co.uk/news/uk-england-devon-65074972

[2] https://networknature.eu/tree-diversity-3-30-300-rule

Table 1. European subregions and key urban forestry themes

EUROPEAN SUBREGION	EXAMPLES OF KEY THEMES
Nordic/Scandinavia	Health equalities, integration, adaptive management
Northwest Europe	Mosaic governance, partnerships, stakeholder engagement, environmental education
Mediterranean	Urban heat island impacts, urban cooling, fire hazards
Central Europe	Levels of participation, inadequate policy linkage, climate change/species adaptation
Southeast Europe	Rural urban migration and lack of integrated policies.

A broad range of urban forestry themes affect all the European subregions to a greater or lesser extent. The priorities that these topics are accorded and the approaches adopted to management vary considerably in relation to local political and regional sociocultural factors.

Examples of urban forestry key themes in Europe

2.1 **NETWORKING**
European Forum on Urban Forestry (EFUF)

2.2 **URBAN FORESTS AS NATURE-BASED SOLUTIONS**
Danube-Auen National Park, Austria

2.3 **DEVELOPMENT OF NOVEL FOREST ECOSYSTEMS**
Ruhr Industrial Forest Project, Germany

2.4 **SPATIAL PLANNING**
Natural England GI Design Principles, United Kingdom of Great Britain and Northern Ireland

2.5 **POLICY**
The Pla Natura Barcelona, Spain

2.6 **GOVERNANCE**
Boscoincittà Park, Milan, Italy

2.7 **SOCIAL EQUITY**
Picasso Urban Food Forest, Italy

2.8 **HEALTH AND WELL-BEING**
The Natural Health Service (NaHS)

2.9 **FUNDING AND ECONOMIC ASPECTS**
Valuation of ecosystem services, Oslo, Norway

4.2 Networking

A case study: European Forum on Urban Forestry

EFUF
European Forum
on Urban Forestry

Source: https://efuf.org

Given considerable differences between Europe's subregions and individual countries, one major achievement is that there is active transnational networking taking place. One of the best-known examples is the European Forum on Urban Forestry (EFUF), which first met in 1998 and is now celebrating its twenty-fifth anniversary. EFUF is a meeting place for practitioners, policymakers, managers, educators and scientists who are active in the field of urban forestry, urban greening and green infrastructure. EFUF has recently become an incorporated network organization and still holds true to its original purpose as a forum of exchange between those involved in practice, research and policy. Since 1998, the Forum has met once a year (2023 in Krakow, Poland and will meet in 2024 in Zagreb, Croatia), but is increasingly supporting other activities. EFUF has also had global significance, having acted as a model for similar initiatives in other regions. Urban forestry information, topical stories and outcomes are made available through the easily accessible web platform (https://efuf.org). The events section of the website aims to spread events, workshops and other kowledge-sharing opportunities to different stakeholders interested in urban forestry and related fields. This has now been complemented by the innovative "myEFUF" App, which brings all that is new in the world of urban forestry directly to users.

4.3 Urban forests as nature-based solutions

Case study: The Danube-Auen National Park, Austria

Across Europe, urban forests are increasingly perceived as potential nature-based solutions, which can address some of the current challenges that cities face, while providing diverse services for human well-being and biodiversity. Recent studies led by the EU-funded Clearinghouse project and the EFUF 2023 edition, based on the theme of urban forests as nature-based solutions, suggest that urban forests and green areas provide a set of critical ecosystem services which play a key role in enhancing livelihoods and the resilience of cities. Although many European cities have a long tradition of tree planting, establishing urban parks and ownership and managing forests, the potential of urban forests remains to be fully realized. An increasing number of new challenges affect the implementation of urban forestry in Europe and its long-term and effective management and integration within urban areas. For example, many European cities, especially in Western and Southern Europe, are experiencing the intensification of heat stress episodes because of the global and local changes in climate conditions (Nicholls and Alexander, 2007).

As a case study, the 93-km^2 Danube-Auen National Park, in Vienna and Lower Austria, aims to provide multiple ecosystem services by combining the urban

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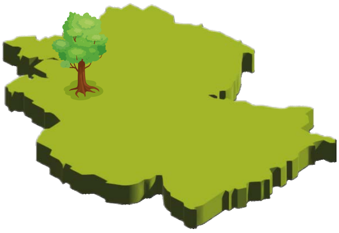
Photo 1. The Danube-Auen National Park forest with regulating services, such as water protection and retention, carbon sequestration, and micro-, local- and regional-climate regulation. The National Park fosters an environment that provides habitats and biodiversity for animal and plant species to enhance supporting ecosystem functions while its blue and green infrastructure further aims to meet cultural functions by offering open spaces for recreational value, thus allowing urban dwellers to find aesthetic pleasure, a sense of place and inspiration. Although influenced by urbanization, the Danube-Auen National Park preserves the last remaining major woodland–wetland environment in the area, hence emphasizing the importance of its protection. Another strong point is the ecological connectivity and functionality across urban regenerated sites, and in this case, the "green ribbon" connecting the conurbations of two major European cities – Vienna (Austria) and Bratislava (Slovakia).

4.4 Development of novel forest ecosystems

Case study: the industrial Forest Project, Ruhr Region, Germany



Climate change, including prolonged periods of drought within many parts of Europe, has resulted in the deterioration of forests and the death of many trees, directly through soil moisture deficit and because of pest- and disease-related problems such as spruce bark beetles. To counter these stresses, new approaches to management are emerging, which involve greater structural and species diversity within woodlands to increase stand resilience and adaptive capacity. Increasing the connectivity of urban forest habitats is also seen as beneficial in terms of biodiversity conservation and allowing the movement and dispersal of species in response to climate change impacts. Many European cities have been developing green infrastructure plans that specify the creation of new woodland corridors and treelined streets in order to enhance physical and functional connectivity between urban areas and extensive semi-natural habitats in peri-urban and surrounding rural hinterlands. Another point of interest is the establishment of urban forestry either by planting or natural regeneration on former industrial sites. As a case study, the "Industrial Forest Project" in the Ruhr area (North Rhine-Westphalia, Germany) is a multifaceted initiative that aims to address significant environmental and social challenges.

The Industrial Forest Project's aim has been to create a sustainable and ecologically diverse forest landscape that contributes to the revitalization of the region and improves its ecological resilience. The Project has enabled the conversion of former industrial sites into forest areas through the process of natural succession. To this end, selected fallow areas were left to regenerate naturally, eventually resulting in the development of a diverse mature forest. The foresters in charge intervened only selectively to ensure the protection of designated forest paths or to preserve habitats considered important for nature conservation. As a result, these forests served as natural habitats for providing diverse ecosystem services such as carbon sequestration, air purification, cooling and new soil formation. By converting derelict sites into green spaces, the project has improved the quality of life of the region's residents by providing opportunities for recreational spaces close to nature and social and cultural opportunities for all age groups. Another important aspect of the Industrial Forest Project has been to engage the public through education on sustainable development themes, thereby creating a sense of local ownership and responsibility. Regular monitoring of research plots within the forest has also helped to involve the population actively through citizen science initiatives. Furthermore, the Industrial Forest Project features educational resources for children, including a previous transformer station that has been converted into a visitor interpretation centre. In some areas, such as the Rheinelbe (slag heap) from the former coal industry at Zollverein in Essen, sculptures and other artworks have been integrated into the forest landscape. The project has been enthusiastically supported by the Government of North Rhine-Westphalia.

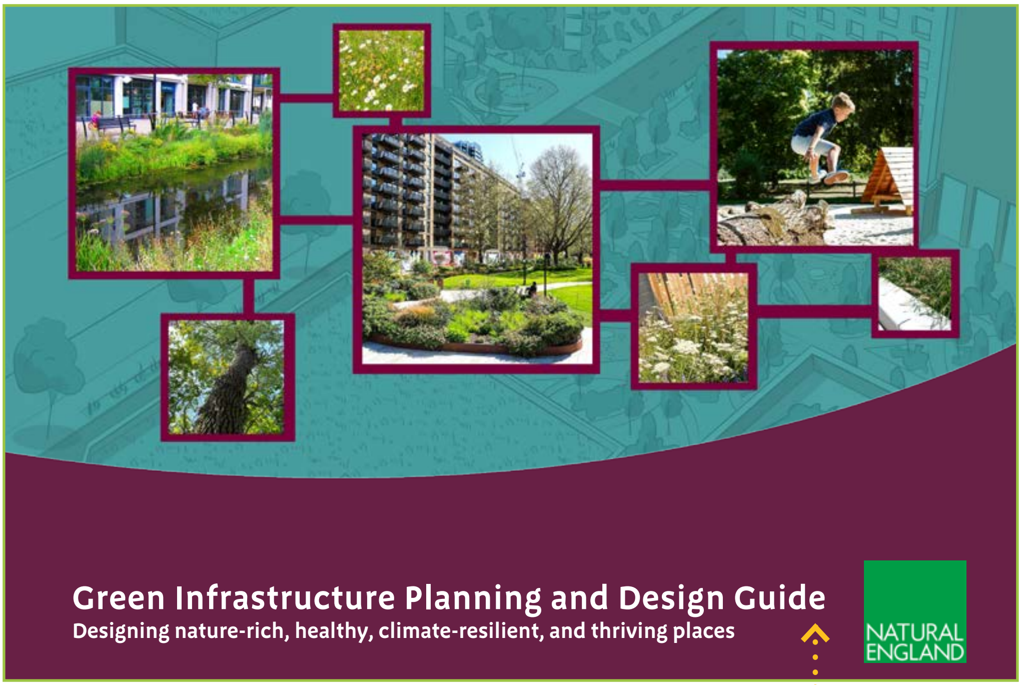
© Photo courtesy of Barbara Darr

Photo 2. Main access path to the industrial forest project Rheinelbe in Gelsenkirchen, Germany

4.5 Spatial planning

Case study: Green Infrastructure Planning and Design Guide, United Kingdom of Great Britain and Northern Ireland

Spatial planning in Europe is very strong and in the context of urban green infrastructure, urban forestry has been gaining more attention in Europe for its potential to contribute towards ecosystem services provision and restoration. It is now embedded within European policy (EU, 2013). These are valuable mechanisms for sustainable urban and regional development, but face major challenges such as ongoing development pressures, the general pace of change within built environments, a lack of coherent policies and tight municipal budgets. These issues restrict options and encourage municipalities to maximize returns from existing assets. Despite these challenges, urban forest strategies, new urban greening plans and local projects, which involve cooperation between local authorities, businesses and civil society groups, present recurring planning opportunities.



Green Infrastructure Planning and Design Guide

Designing nature-rich, healthy, climate-resilient, and thriving places

Source: https://designatedsites.naturalengland.org.uk/GreenInfrastructure/DesignGuide.aspx

A good example is the Green Infrastructure Planning and Design Guide, produced and promoted by Natural England, which aims to provide practical, evidence-based advice on how to plan, design, deliver and manage good quality green infrastructure. This helps to create beautiful, nature-rich places that support people's health and well-being, make places more resilient to climate change, and establish attractive investable places that are good for the economy (Natural England, 2023). It is aimed primarily at local authorities that are responsible for generating design codes. It is also intended to be of value to a wider group that includes planners, developers, urban designers, engineers, landscape architects, ecologists and neighbourhood planning bodies, as well as anyone responsible for the development and management of accessible natural green spaces and other green infrastructure. Furthermore, it aims to help other sectors, including health, transport, energy, education, heritage and regeneration, to identify opportunities for delivering their policies. Accordingly, the goal is to integrate and mainstream good green infrastructure solutions. Notably, the guide recognizes the major role played by urban trees, which in the United Kingdom are a major component of most green infrastructure in urban areas.

4.6 Policy frameworks

Case study: Barcelona Nature Plan, Catalonia, Spain

The European Union's Biodiversity Strategy for 2030 sets an ambitious target of planting at least three billion additional trees by 2030, emphasizing cities as crucial focal points for this initiative. The strategy calls for a systematic inclusion of green spaces, healthy urban ecosystems and nature-based solutions in urban planning, ensuring that grey infrastructures (e.g. buildings and roads) harmoniously integrate with their natural surroundings. Aligned with this strategy, the European Union has also called on European cities to develop urban greening plans through a 'Green City Accord' movement to facilitate the implementation of measures in order to create biodiverse and accessible urban forests, and improve connections between green spaces. The Pla Natura Barcelona (Barcelona Nature Plan) is a good example of this policy effort (Parés and Rull, 2022): it is a 10-year policy plan to improve and increase the provision and access to green spaces and biodiversity in Barcelona by 2030, which includes the contribution made by urban forestry.

As a public initiative by the Barcelona City Council, the Barcelona Nature Plan provides continuity and upscales the "Pla del verd i de la biodiversitat de Barcelona 2020" (Barcelona Green Infrastructure and Biodiversity Plan). It also complements the "Pla Clima" (Climate Plan), which has been under implementation since 2018. Following the Declaration of Climate Emergency of the Barcelona Metropolitan Area (AMB) of 2020, the Plan focuses upon delivery across three key areas: (i) conservation; (ii) increasing the number of green spaces and biodiversity; and (iii) increasing awareness of the importance of green spaces. Cross-cutting themes of the Plan focus on better knowledge and governance. The Barcelona Nature Plan promotes the use of the "Carta del verd i de la biodiversitat" (Technical guidelines for green spaces and biodiversity) when developing projects related to urban and green planning. These technical guidelines provide detailed specifications relating to factors such as soil quality, the spacing between trees and noise reduction characteristics. The Barcelona Nature Plan's goals are diverse but interconnected:

- ✓ **INCREASE THE GREEN INFRASTRUCTURE** to maximize services related to climate change adaptation and citizen access to urban nature.
- ✓ **CONSERVE AND FOSTER BIODIVERSITY** by protecting species, improving habitats and connectivity.
- ✓ **PROMOTE ECOLOGICAL MANAGEMENT** of resources, natural heritage and green urban areas with citizen and biodiversity health in mind.
- ✓ **INCREASE KNOWLEDGE, ENJOYMENT AND PROTECTION** of urban nature, and enable and promote citizen engagement in nature conservation.

© Photo courtesy of Clive Davis

Photo 3. Llobregat ecological corridor

4.7 Governance

Case study: Boscoincittà, Milan, Italy

European cities have adopted a variety of governance approaches, varying between legally mandated citizen consultation to co-governance approaches. Some successful approaches entail digital participation tools, public information desks and participatory budgeting. However, across many regions, the potential for public participation and co-governance approaches still seems to be underestimated and focuses mainly on the lower tiers of citizen engagement, i.e. information provision and consultation. This situation could be partly due to a lack of municipal capacity and the general lack of required organizational flexibility and support to facilitate citizen involvement

(Wamsler *et al.*, 2020). Enhancing the adoption of 'mosaic governance' – an approach that blends multiple governance strategies and stakeholders – seems to be a key challenge for urban forestry throughout Europe. However, a general increase in civil society stakeholder groups interested in green spaces can be regarded as a positive signal. In many cities, there is potential to increase engagement and create opportunities for stakeholder networks and new partnerships (Buijs *et al.*, 2019).

A remarkable case study is "Boscoincittà", a public park in the western outskirts of Milan, Italy, which since 1974 has transformed semi-derelict areas into a green and blue space for the city. Promoted by Italia Nostra, an association that protects cultural and environmental heritage, Boscoincittà was the first example of a planned urban forest in Italy. At the time, this was a revolutionary concept, and also a good case study for bottom-up stakeholder and citizen participation in urban forests as a nature-based solution. Today, Boscoincittà forms a much used and popular public park of 120 ha on land that is provided by the municipality of Milan, featuring many diverse habitats including urban woods, meadows, streams and wetlands. There is also an area for community gardening, hosting 200 allotments, which are managed by the citizens. Boscoincittà offers ecological, climatic, social, health and well-being benefits. Furthermore, diverse sports and fitness activities, horticulture workshops and environmental education activities take place in this public park, with a strong focus on socially disadvantaged groups and volunteering. Additionally, there is a conference room that hosts meetings between the Centro Forestazione Urbana (CFU, Centre for Urban Forestation) and established stakeholder groups. This is also used as space for children`s activities and seminars for students and professional groups while a 24-bed guesthouse provides accommodation for visiting school and youth groups. In addition, volunteers look after the security of the park, which is open 24 hours a day. The revolutionary approach and the high degree of citizen participation have helped to make Boscoincittà a renowned project that contributes to changing negative perceptions about forests in urban areas.

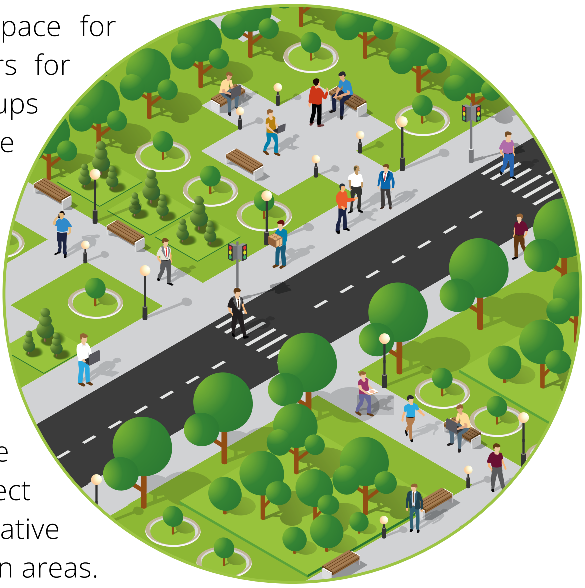


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Photo 4. The ecological area adjacent to social housing

4.8 Social equity

Case study: Picasso Food Forest, Parma, Italy

In the complex field of urban forestry and its impact on diverse stakeholders, the important theme of social equity is receiving increasing emphasis in state- and municipality-sponsored policies and programmes. Awareness is increasing and specific planning approaches or actions are essential to avoid the perception that urban forests are a 'luxury' aimed at beautifying cities (Salbitano, *et al.*, 2016). New city policies often emphasize social cohesion and the need to tackle inequality. However, these goals are not always fully incorporated within green space planning principles, thereby largely ignoring or insufficiently addressing urban tensions and contradictions between different social groups (Oscilowicz *et al.*, 2021).

Fruttorti Parma
ORTI E FRUTTETI CONDIVISI NEI QUARTIERI CITTADINI

The urban community-managed food forest, the “Picasso Food Forest”, which developed from the citizen movement, Fruttorti di Parma, is a good example of a social equity project. The food forest was created on previously abandoned land, which now provides a flourishing recreational and educational green space for the local community, and within an area of 4 500 m^2, different varieties of fruit and vegetables are produced and harvested. This healthy food is accessible to all and helps to promote healthy eating habits. The Picasso Food Forest was the first experimental model of an urban food forest in Parma, and possibly within Italy as a whole. It is a form of ‘public park’ in which trees and plants not only provide aesthetic functions, shade and oxygen, but also provide food for the people living in the area. It developed as a spontaneous and informal citizens’ movement, established in Parma in 2012, with the aim of the group being to create more green spaces across the City of Parma. These green spaces should be accessible to all local inhabitants, while being rich in biodiversity and providing locations for producing healthy and free food. Newly created green spaces are also intended to be places for relaxing, for children to play in, for chatting, for learning and for sharing produce from the food forest.

The group wishes to create an urban network of food forests in which plants provide food for local people while offering habitats similar to natural ones, whereby natural processes regulate the entire system. The food forest attempts to imitate natural processes and functions typical of an immature woodland ecosystem. While a mature forest is made up mainly by big trees and a closed canopy that leaves little light penetration, an immature woodland is characterized by trees of different sizes and heights, shrubs, herbaceous plants, and areas with different levels of shade and light. The Picasso Food Forest also provides an important habitat for promoting biodiversity: more than 300 animal species have been identified, ranging from birds to insects. Similar numbers of plant species occur, including cultivated and volunteer plants. It is a place for citizens to connect, to learn and practise agroecology, and to share their ideas on sustainability, self-sufficiency, community resilience and empowerment.

© FAO

Photo 5. Empowering the next generation: children gather to learn about sustainability and the power of urban forests at Picasso Food Forest in Parma.

4.9 Health and well-being

Case study: The Natural Health Service, United Kingdom

The positive link between urban forests, other urban green spaces, human health and well-being is well known in Europe, supported by evidence-based medicine and social research. Good planning and management are widely understood to be crucial for encouraging everyday use of physical activity and contact with nature. Across Europe, the following issues are all addressed to some extent (Owuor, Whitehead and De Vreese, 2022), but there remains potential for further improvement in further improvement:

- ✓ **EQUITY, ACCESSIBILITY AND DIVERSIFICATION**
- ✓ **INFORMATION AVAILABILITY ON URBAN FORESTS** as well as the health benefits derived from green spaces – crucial for fostering well-being;
- ✓ **SUPPORTIVE PROGRAMMES AND COMMUNITY ENGAGEMENT**

The Natural Health Service (NaHS), based at the Mersey Forest in northwest of the United Kingdom, uses the natural environment to improve the health and well-being of individuals, families and communities across Merseyside and North Cheshire. NaHS provides commissioning bodies with a single point of access to evidence-based service products that can be utilized as part of a holistic approach to health and social care.

© Natural Health Service

Photo 6. Seniors enjoying exercise under the trees in the heart of the Mersey Forest.

As a result, this reduces the pressure upon the National Health Service (NHS) and local authority resources in the medium and long term. NaHS products include the following:

- ✓ **Health walks**, tailored to individual needs and designed to help meet exercise and physical activity targets while improving mental well-being.
- ✓ **Horticultural therapy**, i.e. gardening and food growing activities in a social setting.
- ✓ **Nature-based mindfulness practices**, delivered in local woodlands that support full immersion in the natural environment. Focused on individuals with mild to moderate mental health issues for whom mindfulness practices may form part of a programme to improve mental health and increase resilience from day-to-day triggers of stress, depression and anxiety. Shown to increase the capacity to self-manage long-term chronic conditions.
- ✓ **Forest schools**, targeted at increasing physical activity and improving the mental well-being of young people. They provide an innovative approach to outdoor play and learning, inspiring individuals of any age through positive outdoor experiences. By participating in engaging, motivating and achievable tasks and activities in a woodland environment, each participant has the opportunity to develop intrinsic motivation, emotional and social skills.
- ✓ **Healthy conservation**, that improves a participant's strength and stamina through nature-based conservation projects, boosting practical skills and confidence, increasing physical activity, and building social networks while benefiting local green spaces.

4.10 New approaches to urban forests through an ecosystem service-led approach

Case study: The Hugo BioMass Park, Gelsenkirchen, Germany

The transition to new economic models creates ecosystem service-based opportunities for funding urban forestry. Unlike the traditional extractive and linear fossil-based economy, the circular bioeconomy concerns restoring and sustainably managing biological systems to produce synergistically – food, energy, ecosystem services and bio-based solutions to decarbonize the economy while generating jobs and prosperity. This requires that society recognizes and invests in biodiversity as its true driver (Palahí *et al.*, 2020). Presently, there is interest in the concept of BioCities, and a new facility was launched by the European Forest Institute (EFI) in Rome to promote this. EFI has taken the lead in commissioning work, which has resulted in the publication of a Springer Future City book titled "Transforming BioCities" (Scarascia-Mugnozza et al., 2023). This publication advocates a number of concepts and approaches to address the challenges related to green infrastructure (GI) and urban forestry (UF). The benefits of GI and UF for humans have been expressed as ecosystem services, which are nevertheless seen as challenging in current planning, design and management

© Clive Davis

Photo 6. Biomass Park Hugo

practices for organizational regimes. Hence, there is a need to address planning, design and management as holistic processes, which allow nature to prevail, adapt and change over time, instead of considering these different steps as separate practices.

An example of an ecosystem service-led approach is the BioMass Park Hugo in the Ruhr region of Germany. This previous coal mine was transformed for multifunctional use by providing a range of ecosystem services including ecological education, nature protection and recreation and by creating interpersonal bonds (including neighbourhood networks). The central part of the site serves as a "landscape laboratory" with a test area for tree species that are cultivated specifically for producing biomass and a wood supply area used by nearby schools and kindergartens. A community garden was also designed to meet the needs of a multicultural neighbourhood; fruit, vegetables and herbs, insect houses, picnic areas and places for small-water retention are combined in an intimate mix with urban forest elements.

4.11 Conclusions

Urban forestry in Europe is well-established and is currently in a good position within ongoing debates on ecosystem services, nature-based solutions, urban greening plans and green infrastructure. There is strong networking and an increasing interest in spatial planning and urban design. In recent times, the relationship between urban forests and tackling urban problems has been brought to the fore. However, urban forests are still seen as a lesser priority with respect to urban regeneration, job creation and development. Despite progress in some areas, mistakes continue to be made in both planning and management, and some very detrimental high-profile cases generate media attention, including localized tree removal. Compared to the last century, progress has been made, especially at the project level, and the outlook is generally positive, especially in relation to the debates taking place around climate change adaptation, health and well-being and nature recovery. Nevertheless, progress is by no means assured as there are voices that wish to diminish a nature-positive approach.

Acknowledgements

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The European Forum on Urban Forestry (EFUF) is a meeting place for practitioners, policymakers, managers, educators and scientists who are active in urban forestry, urban greening and green infrastructure. Since 1998, it has met annually to discuss new developments, to share experiences, and to review examples of good practices on the planning, design and management of urban forests (from woodland to urban parks and street trees). (**http://www.efuf.org**)

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5

URBAN FORESTS: A PERSPECTIVE FROM THE NEAR EAST AND NORTH AFRICA

“Towards urban forestry principles that are culturally and contextually relevant”

AUTHORS

Federica Di Cagno, FAO; Simone Borelli, FAO; Michela Conigliaro, FAO

URBAN FORESTS: A PERSPECTIVE FROM THE NEAR EAST AND NORTH AFRICA

5.1 Urbanization patterns in the Near East and North Africa

During the twentieth century, the Near East and North Africa region (NENA) experienced a remarkable demographic surge. Notably and more recently, between 1960 and 2021, the regional population grew sixfold, surpassing the threefold global increase. As of 2021, the NENA region was home to approximately 550 million people, with Egypt leading the population count and Bahrain having the highest population density (UNDESA, 2022; FAO, 2022a).

> *The Near East and North Africa (NENA) region stretches along the southern and eastern shores of the Mediterranean Sea, and includes the Arabian Peninsula, Iran, North Africa, and occasionally even more distant territories. The region has historically been seen as a frontier and also as a meeting place where European, African and Asian worlds converged in a fusion of cultures and traditions.*

Projections suggest that by 2050. the population of NENA countries will approach 700 million, with approximately 690 million, or 90 percent, residing in urban areas (UNDESA, 2022). This rapid urbanization will present numerous challenges, including increased poverty, food insecurity, pollution and limited resource accessibility. As urban areas expand, wealth tends to concentrate in urban centres, while peri-urban and rural areas suffer from underdevelopment. Moreover, the demand for land and infrastructure often takes precedence over the allocation of green spaces (Hutchings *et al*., 2022). This results in limited availability and accessibility of urban green areas, particularly in countries like Egypt, where the pace of urbanization has outpaced the implementation of sufficient green infrastructures. Therefore, residents, especially those from lower socioeconomic backgrounds, are deprived of the numerous benefits that urban forestry can provide, including improved well-being, recreational opportunities, and enhanced quality of life (Moursy, 2018; Aly and Dimitrijevic, 2022).

The disparities in wealth and resources between countries within the NENA region further exacerbate the gap in their abilities to plan and manage urban growth in a socially and environmentally sustainable manner. While some countries have the means to invest in sustainable infrastructure and create well-designed, green urban spaces, others struggle to provide even the most basic amenities and infrastructure for their rapidly growing urban populations.

5.2 Sustainable urban development in the NENA Region – challenges and strategies

The NENA region is renowned for its arid and water-scarce environments, presenting substantial challenges for sustainable urban development and the implementation of green infrastructure. Water scarcity is a major concern, as the region has the lowest water resources per capita globally and is facing the depletion of groundwater reserves and aquifers. This situation is expected to worsen in the coming decades, with more frequent and severe droughts anticipated (El Chami *et al.*, 2022). The region's population growth and heavy reliance on fossil fuels further complicate sustainable urban development. These characteristics make NENA countries highly vulnerable to the adverse impacts of climate change, exacerbating socioeconomic challenges.

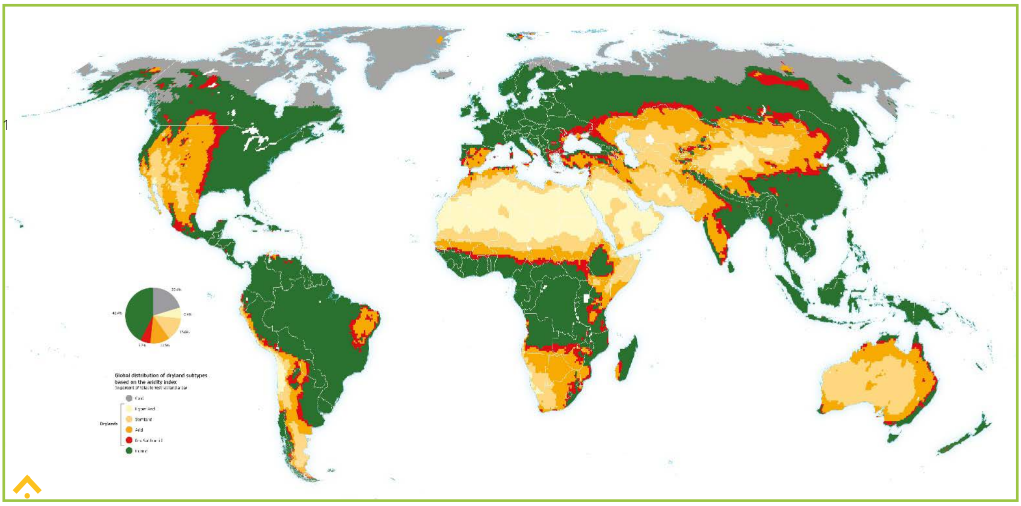

Global distribution of dryland subtypes based on the aridity index
Cold
Hyper Arid
Semiarid
Arid
Dry Subhumid
Humid
Drylands

Figure 1. *Global patterns of aridity over the periods from 1951-1980 and 1981-2010*
Source: Global Precipitation Climatology Centre and potential evapotranspiration data from the Climate Research Unit of the University of East Anglia (CRUTSv3.20), WAD3-JRC, modified from Spinoni J. 2015 [AP] https://wad.jrc.ec.europa.eu/patternsaridity

One of the primary obstacles in the NENA region is the lack of coordination among relevant institutions, leading to unplanned urbanization. The close connections between government and business interests often result in a top-down planning approach that prioritizes immediate investment returns over long-term sustainability. Consequently, incorporating green infrastructure and sustainable practices into urban development has often been overlooked (Alawadi, 2017). Central technical bodies typically develop urban policies and plans, while local authorities struggle with limited resources, knowledge, and expertise to effectively manage urban growth and implement and maintain green infrastructures. Limited cooperation among stakeholders, including inadequate social participation, also hinders the development of sustainable urban environments in the NENA region. This lack of collaboration prevents the holistic integration of diverse perspectives and expertise necessary for sustainable urban planning and design, as shown in the Arab Strategy for Housing and Urban Development 2030 (UN-Habitat, 2016).

Furthermore, research on sustainable urbanism primarily focuses on Western societies, neglecting the specific context of NENA countries. The rapid growth rates, unique environmental conditions, political systems and cultural beliefs in this region render much of this research inapplicable to the local contexts. Notably, cities like Dubai have experienced rapid and unprecedented development, contrasting with the gradual processes observed in Western cities (Bagaeen, 2007). As a result, urbanization in dense NENA cities often leads to fragmented and exclusive urban forms, lacking integration with the natural and social landscapes.

5.3 Living systems model and the integration of green infrastructure in urban development

Sustainable urban development has become a global imperative in the face of increasing urbanization and environmental concerns. The NENA Africa region, with its unique socioenvironmental context, presents both challenges and opportunities for implementing sustainable urban development. What is the role of green infrastructure in promoting sustainable urban development in the region?

In particular, in hyper-arid cities, urban forestry and urban greening can play an even more significant role than in temperate zones. They offer valuable tools to address the main challenges faced by urban communities in a cost-effective and efficient manner (FAO, 2022b). In fact, trees play a crucial role in water conservation, because their shade and their ability to reduce evapotranspiration contribute to improved water infiltration into the ground. The presence of native trees and green belts in countries like Kuwait has been shown to significantly control sand and dust hazards, mitigating climate change and slowing the expansion of desertification. (Al-Dousari *et al*., 2019).

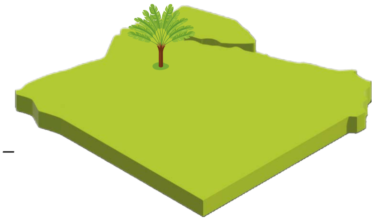
Green infrastructure also mitigates heat island effects, reducing the need for air conditioning in buildings and creating more pleasant microclimates for urban residents. Studies conducted in Amman, Jordan have demonstrated that trees can reduce the cooling load of buildings by up to 35 percent (Abdel-Aziz and Al-kurdi, 2014) and that green spaces experience lower temperatures than non-green spaces in Cairo, Egypt (AboElata, 2017). Additionally, trees and greenery generate monetary value, as evidenced by the dramatic increase in land values following the plantation of a green belt in Ouarzazate, Morocco (UNEP, 2017).

A striking example of green infrastructure implementation is the Green Riyadh project undertaken in the capital city of Saudi Arabia. The initiative aims to transform Riyadh into a sustainable, eco-friendly city with a focus on improving the quality of life for its residents while preserving the natural environment. Under the Green Riyadh project, several initiatives have been implemented to enhance the city's green spaces and promote a healthier lifestyle. The initiative involves the planting of millions of trees across the city, creating new parks, and expanding existing ones. This massive reforestation effort not only improves the city's aesthetic appeal but also helps combat air pollution, reduce the urban heat island (UHI) effect, and increase biodiversity.

In addition to environmental benefits, green infrastructure has significant social and cultural impacts. Well-designed and well-distributed urban forests can create healthier environments, promoting physical and mental well-being for urban residents (Wolch, Byrne and Newall, 2014; Shuvo *et al*., 2020). They also serve as important settings for local activities and events, fostering social stewardship of the urban environment and stronger communities. Case studies from Jordan have demonstrated the positive impacts of green infrastructure on social cohesion and the preservation of local cultural values (GIZ, 2017). By beautifying all areas of a city equally and providing green spaces for various community activities, a sense of belonging and social connection can be nurtured (FAO, 2022b).

Efforts have been made to foster social inclusion in the regeneration of urban green areas in some NENA countries. The Amman Green Cities Action in Jordan, for instance, exemplifies the successful integration of green spaces based on the perspectives and preferences of local residents.

5.4 Urban farming as a tool to mitigate losses of urban green spaces and agricultural land encroachment in Cairo, Egypt



Abdallah Tawfic
Co-founder of Urban Greens Egypt
Adviser – Nile Delta Water Management Programme – The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Overview

Many megacities worldwide are currently affected by the adverse impacts of climate change. The UHI effect and food insecurity are major issues in many cities due to rapid unplanned urbanization and population growth, and the lack of appropriate climate change mitigation and adaptation strategies being applied. Furthermore, many cities, especially in the developing nations, have almost driven out agricultural practices from their boundaries. Consequently, food has to be driven hundreds of kilometres from field to table, consuming a great deal of energy in transportation.

The urban fabric of Cairo has significantly transformed over the past four decades. New cities have grown east and west of Old Cairo because of continuous population growth and increasing demand for housing needs. These residential trends have expanded urban agglomerations onto agricultural lands at the peripheries of Cairo (north, northeast and northwest), leading to the loss of valuable agricultural production. Even in the heart of Cairo, many public urban green spaces and street trees have been removed at the expense of road expansion to try to resolve traffic congestion. Between 2017 and 2020, Cairo lost around 9 000 m^2 of its already limited green areas. As such, areas such as Heliopolis and East Nasr City lost around 3 000 m^2 of green space each (Aly and Dimitrijevic, 2022).

Since cities like Cairo are growing at a fast rate, it is necessary to identify new approaches that can counteract the loss of valuable urban green spaces and encroachment on agricultural land. The aim is to empower local communities to produce and deliver local products within the boundaries of the city by utilizing contemporary and local approaches, and create dynamic social spaces that support urban dwellers in physical contact with the natural environment, thereby bringing nature back to the cities with all its environmental benefits.

An urban forest is defined as trees, shrubs and green spaces within an urban area, including individual trees, street trees, green spaces with trees, and even the associated vegetation and the soil beneath the trees (cities4forests, 2022). Hence, urban agricultural practices within the boundaries of the city can also contribute to urban forestry elements. Since Cairo is an arid city, it is especially necessary to protect and support urban green infrastructure and find ways to develop smart strategies and interventions. Urban agriculture is a beneficial strategy that can be advantageous to food security in Cairo by providing clean and fresh produce within its boundaries, thus creating awareness among the local communities about the gains of locally grown crops, as well as the environmental rewards that urban agriculture can bring. Disseminating urban agriculture on a larger scale can enable new markets for producing, packing, marketing and selling fruit and vegetables, creating job opportunities within the local community. In addition, the food miles can be reduced by bringing production closer to consumption, thus decreasing the energy needed for transportation, and eventually greenhouse gas (GHG) emissions.

Integrating urban agriculture within the broader concept of urban forestry can compensate for the loss of green areas in densely populated Cairo and create

more shaded spaces that help mitigate the impacts of UHI effects and the rise of city temperatures. Practising urban agriculture on roofs or within empty pockets of residential neighbourhoods, as well as school yards and public buildings, could also address the issue of lack of social gathering spaces. This will help create community venues in abandoned spaces and strengthen community bonds through shared planting and agricultural practices.

With the current need in Cairo to spread the concept of green infrastructure, implementing diverse projects is a vital key for promoting and understanding the social, technical, environmental and economic feasibility of urban agriculture within the local context. Furthermore, focusing on education and awareness is an important tool for the concept to be disseminated. As such, urban agriculture projects that empower youth and women can enable a culture of practices that widen the participation of society, and new innovations can arise.

Urban Agriculture Project – the American International School in Egypt

The American International School (AIS) is a private school with two campuses in Cairo (AIS East and West), situated in the new satellite cities of Cairo. AIS – West initiated a programme in 2018 called Go Green, which aims to educate students as well as teachers about the efficient use of different resources, including water, energy and food. The school believes in the importance of educating their students from the early stages about the benefits and methods of urban farming, and integrates theoretical and practical activities in the school.

The project was able to highlight the advantages of urban agriculture to students, teachers and school staff. The school also conducted several awareness classes to identify the linkages between growing food and the environmental benefits of urban green spaces. Indeed, connecting urban farming and food production to the broader ecological and social benefits of urban green infrastructure was one of the main targets of this project. In the programme, the urban farming infrastructure spanned over 200 m^2 within the school premises, with farming systems varying from hydroponic systems to raised beds to indoor vertical systems using artificial lighting.

The school developed their programme using practical ideas for students' engagement. Different crops were assigned to students from the first planting day until harvesting, with the aim of providing students with a sense of the amount of effort and time needed for plants to grow, and understand the different stages. They also had classes dedicated to exploring their taste buds, and trying to identify differences between fresh and stored products.

The students also recycled unused paper boxes, which were coloured and reused for collecting produce, aiming to promote the concepts of reduce, reuse and recycle, and to discourage them from single-use plastic bags. Furthermore, the school sold produce to parents and teachers to support the operations and maintenance costs, and collaborated on several events with the Egyptian Food Bank to donate to communities in need, thus fostering community development among students, teachers and other school staff.

The school administration believes in the importance of resource efficiency and of growing fresh produce instead of purchasing it. In this context, a composting tumbler is used to generate organic fertilizer from food and garden waste. The school also collaborates with a nearby community kitchen, and has introduced the concept of growing food vertically using artificial lighting inside classrooms, from materials that are locally available.

© Photo courtesy of the American International School

Photo 1. AIS student holding crops produced at their Urban Farm

Conclusions

Urban agriculture is a vital tool that can mitigate the loss of urban green spaces in cities and be combined with new means of sustainable food production. With the current global issues facing many cities around the world, especially rising inflation rates and spikes in prices of basic services including food, there should be a focus on community-based approaches and projects that can mitigate these challenges and support local communities with their everyday needs, especially in the developing nations. This approach should also work hand in hand with environmental strategies such as urban forestry that can help reduce the adverse impacts of climate change on cities.

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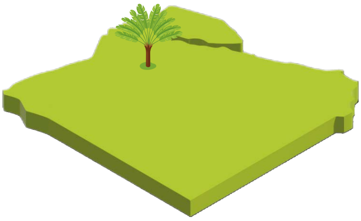
5.5 Urban Micro-Lungs – mini-forests for climate, biodiversity and well-being in Amman, Jordan



Project manager – The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
Project partners – Greater Amman Municipality, Ministry of Environment
Research, design & supervision – TAYYŪN Research Studio
Community coordinator – Dibeen Association for Environmental Development
Project implementation – Royal Greens
Native plants nurseries – Mujeb Nursery; Royal Botanic Garden; Forestry Department

Cities have become one of the main culprits of environmental degradation. Despite accounting for less than 2 percent of the Earth's surface, urban landscapes are the biggest contributors to climate change, biodiversity loss and health problems. According to UN-Habitat (2022), cities produce about 70 percent of the world´s greenhouse gas emissions and consume 80 percent of the world's energy. As a result, urban growth is causing fragmentation and destruction of many high-biodiversity habitats while ambient air pollution in major cities accounts for an estimated 4.2 million deaths per year, as revealed by the World Health Organization.

Yet, what if urbanization were a restorative act of the land, no longer synonymous with ecosystem destruction? What if our neighbourhoods, streets and public spaces were resilient, generous and regenerative habitats for all life forms? What if our gardens and parks were havens of untouched nature, clean air and wild fruits instead of a cosmetic afterthought?

While the possibility of restoring urban nature in inner cities and densely populated areas seems to be doubtful, mini-forests are springing up in many cities around the world, including Tokyo, New Delhi and Paris. Citizens, communities, developers and city leaders are creating these forests in parks, schools, industrial areas, alongside roads, in parking lots, and in home gardens! Using a unique Japanese method for forest creation, known as the Miyawaki method, cities can now be home to thousands of these small forests using public spaces, private land and even urban leftovers to restore native biodiversity and human health.

© Photos courtesy of TAYYŪN Research Studio

The Miyawaki method

Developed by the Japanese renowned botanist, Akira Miyawaki, the method creates ultra-dense, highly-biodiverse, multi-layered native forests that are 30 times denser and that grow 10 times faster than conventional plantations. The process starts with soil engineering, and is based on dense planting of carefully selected primary and secondary species, accelerating the establishment of self-sustaining, maintenance-free, native forests – almost anywhere.

With limited urban space available, fast-paced development and increased pollution, the Miyawaki method offers effective environmental solutions that are urgently needed – multiplying the social, spaces in a fraction of time, and triggering the remedial processes for restoring soils, air, water economic and environmental benefits of urban green, microclimates and whole ecosystems.

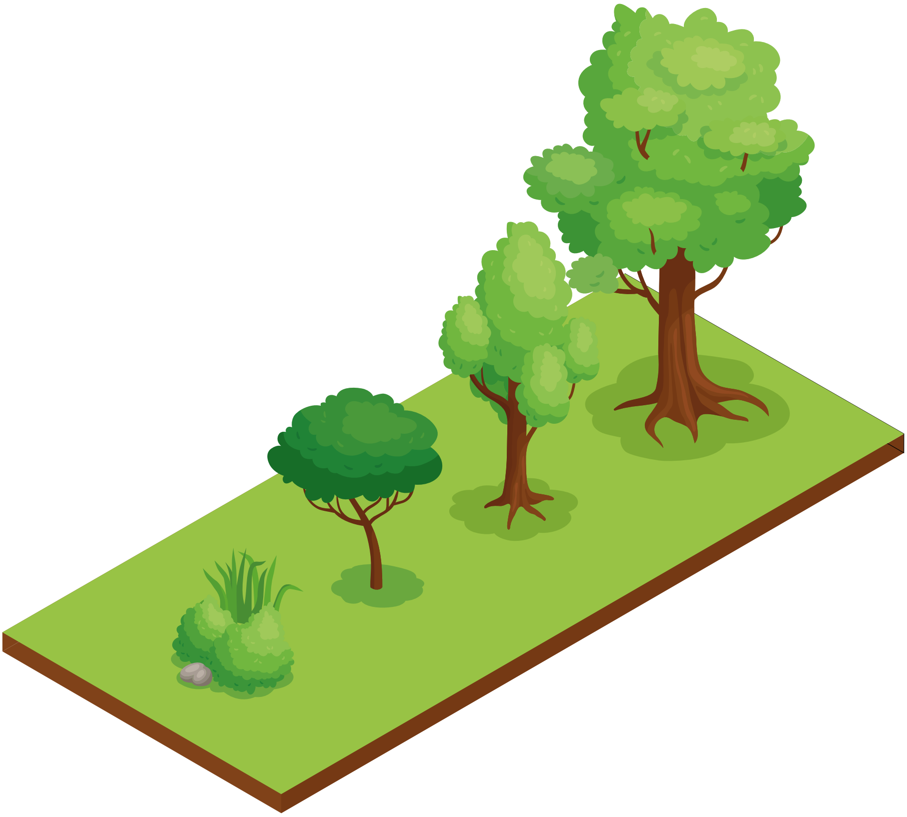
The Urban Micro-Lungs Project

With densely populated neighbourhoods, overburdened infrastructure, and little or no access to public and green spaces, two areas in East Amman were identified to pilot the Urban Micro-Lungs Project.

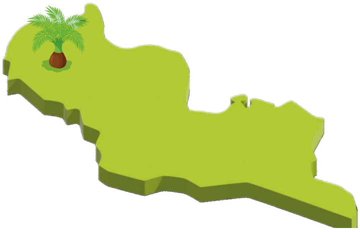
Aiming to improve the well-being of inhabitants and promote climate resilience and urban justice, the project adopts the Miyawaki method to transform two urban leftover spaces into lush forests of rich native biodiversity. Each of the selected sites has an area of only 100 to 250 m^2 that has now been activated as living green tissue amid the dead concrete jungle. The selected sites act as acupuncture interventions that trigger the restoration of essential ecosystem functions in their localities. As the dense native forests grow, they help reduce pollution, enhance flood resilience, regulate microclimates, save energy, improve air quality, regenerate dead soil, sequester carbon, support biodiversity, and improve people's health and well-being.

By adopting the Miyawaki method, the project also aims to enhance greening strategies in the city of Amman. Parallel to implementation, the project has formed partnerships with the Greater Amman Municipality and the Ministry of Environment, providing a series of workshops and training sessions to build municipal staff capacity and integrate the Miyawaki method into urban landscape design across the city. The project explores how authentic native 'wilderness' can replace manicured artificial landscapes in dense urban settings. It calls for mainstreaming native species and creating maintenance-free mini-forests that optimize the use of limited water resources in the world's second water-poorest country.

Yet this project is not solely about physical interventions. It revolves around the community living and working in and about the forest sites, and aims to establish a sense of ownership and responsibility towards these newborn public spaces. While this process is challenging, real solid transformation takes time. A series of community activation sessions was arranged to raise awareness of the environmental benefits of green infrastructure. Community members, including men, women, children and older residents, have participated in initiatives, specifically youth initiatives, in planting native trees and shrubs. And to develop long-term engagement, the project includes a junior rangers' programme involving young boys and girls in forest observation and growth monitoring during the first two years of establishment. As a learning opportunity, this programme opens a window for children to know the native plants of their land, add the names to their vocabulary, and the forms and scents to their memory, thereby gradually building local knowledge and long-lasting connections.



5.6 Urban and peri-urban forests in Tunisia – a case study of the innovative Sidi Amor peri-urban forest project



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Contact author: sondesfkiri@gmail.com

Urban and peri-urban forests in Tunisia – importance, challenges and protection initiatives

Urban and peri-urban forests (UPF) play an important role in the sustainability and well-being of cities by reducing carbon emissions, mitigating UHI and improving air quality and thermal comfort for residents. In addition, Kuo, Barnes and Jordan (2018) have shown that forests and other urban green spaces improve people's mental and physical health by reducing stress and promoting well-being. Thus, UPFs are essential for creating resilient and sustainable cities.

In Tunisia, as elsewhere in the world, people living in rural areas continue to migrate to cities. This rural exodus, which translates into an urbanization rate of 67.8 percent in Tunisia, has led to the creation of urban agglomerations whose populations exceed the national average. Despite the importance of UPF and green spaces in Tunisia for combating the effects of climate change in cities, these precious natural spaces are facing numerous challenges linked to increasing urbanization and human pressures.

State takeover of forest land has given rise to a variety of public and private land tenure systems in urban areas. Conflicts have arisen between owners of former forest land and the forestry administration. Illegal housing estates have sprung up in state forest areas, exacerbated by an opaque legal status. As a result, these UPF are threatened by fire (year after year, precious hectares of woodland in the UPF go up in smoke), vandalism, the spread of squatter settlements and the dumping of rubbish in the context of sometimes ineffective legislation for the protection of urban forests.

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[2] National Research Institute of Rural Engineering, Water and Forests (INRGREF). Sidi Amor Agricultural Development Group (GDA Sidi Amor).

[3] National Research Institute of Rural Engineering, Water and Forests (INRGREF).

[4] Sidi Amor Agricultural Development Group (GDA Sidi Amor).

Furthermore, the legal texts offer no possibility of integrating the local population as users and players in maintaining and exploiting the potential of the UPF's natural resources. Indeed, the vagueness of the texts governing the protection of urban forests exposes them to all sorts of threats, as well as to significant land pressure from certain public players.

Recently, Tunisia adopted an environmental policy that generally promotes green spaces, particularly UPFs, as a means of improving the quality of life for its citizens. This political interest has taken the form of the creation of institutions and a legislative framework, as well as the organization of major awareness-raising campaigns, but without involving local players, particularly the local population. The success of this new policy has been hampered by the lack of management mechanisms, consultation, and of a participatory approach (FTDES, 2022; Kheder and Samaali, 2022).

Nevertheless, there are examples of participatory and integrated management initiatives for the protection and development of UPF, which are being put in place to safeguard these forests and guarantee their long-term benefits, such as that of the GDA Sidi Amor.

© Photos courtesy of Nawaat

Photo 2. GDA Sidi Amor, Tunisia

Agricultural Development Group – providing support for UPF management in Tunisia

The involvement of non-governmental organizations (NGOs) and the role they have played at the international level have been decisive in raising environmental awareness. Concerned about environmental and ecological issues, a number of Tunisian associations have taken on the task of promoting and protecting UPF.

As a support body, the General Directorate of Forestry (DGF) is backing the creation of a grassroots organization, the GDA, and the introduction of contracts for the co-management of forest resources as part of a public–private partnership. The aim is to ensure the sustainable management of natural resources and the transfer of know-how, and to encourage the creation of small- and medium-sized local primary processing businesses.

Case study of the GDA Sidi Amor peri-urban park – an integrative project to preserve the peri-urban forest of Sidi Amor

The GDA Sidi Amor is a Tunisian NGO set up in 2010 and located in the municipality of Rouad, 12 km from the capital Tunis. Its aim is to preserve the peri-urban forest of Sidi Amor, which covers an area of 10.3 km^2.

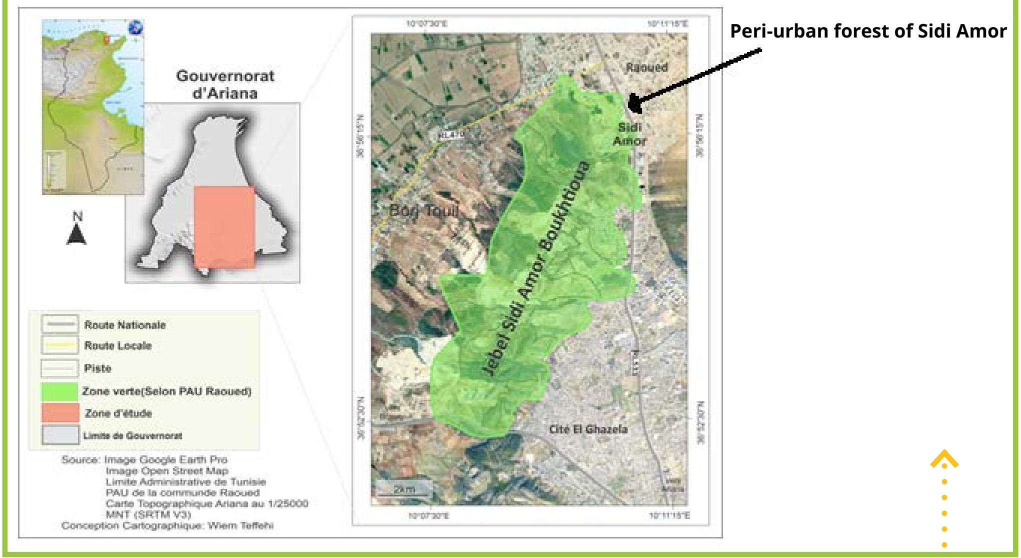
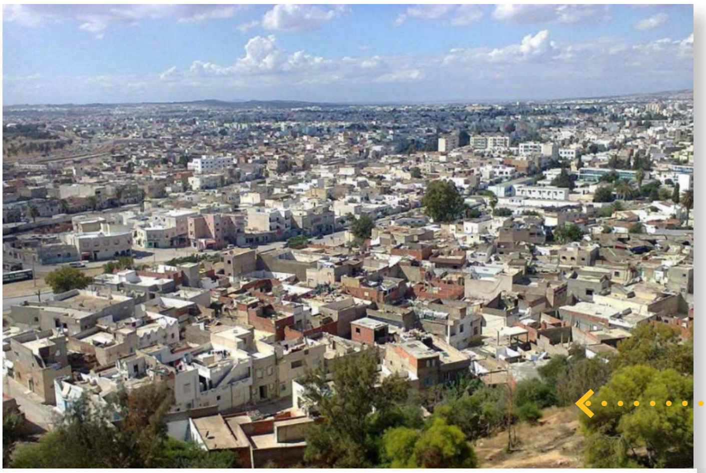

Peri-urban forest of Sidi Amor
Gouvernorat d'Ariana
N
Route Nationale
Route Locale
Piste
Zone verte(Selon PAU Raoued)
Zone d'étude
Limite de Gouvernorat
Source: Image Google Earth Pro
Image Open Street Map
Limite Administrative de Tunisie
PAU de la commune Raoued
Carte Topographique Ariana au 1/25000
MNT (SRTM V3)
Conception Cartographique: Wiem Teffehi
10°07'30"E
10°11'15"E
36°56'15"N
36°52'30"N
Raoued
Sidi Amor
RL470
Borj Touil
Jebel Sidi Amor Boukhtioua
Cité El Ghazela
2km

Figure 2. Location of Peri-urban forest Sidi Amor
Source: Limite Administrative de Tunisie PAU de la communde Raoued Carte Topographique Ariana au 1/25000 MNT (SRTM V3) Cartographic concession: Wiem Teffehi

The starting point of the GDA's action was to respond to a local development issue by enhancing the value of a natural peri-urban site, which is full of contrasts (i.e. GDA Sidi Amor's peri-urban forest): on the one hand, it contains a wealth of resources and remarkable potential for development; and on the other hand, it is an area of poverty combined with multiple threats of clearing the forest. Based on this development approach, the GDA's aim is to transform the site into a genuine territorial development centre so that it would become a source of socioeconomic dynamism for the local population.

The GDA is threatened with degradation due to uncontrolled urbanization, quarrying, erosion and gullying, as well as human negligence. Furthermore, the number of fires has increased fourfold since the revolution in 2011, and these pressures are likely to be exacerbated with the impacts of climate change. The building density increased from 30 buildings per ha in 2004 to 50 buildings per ha in 2021. Thus, the decline in forest area is the result of anthropic actions: construction and overexploitation of its resources.



© F. Salbitano

Photo 3. Municipality of Rouad (94 691 inhabitants in 2014)

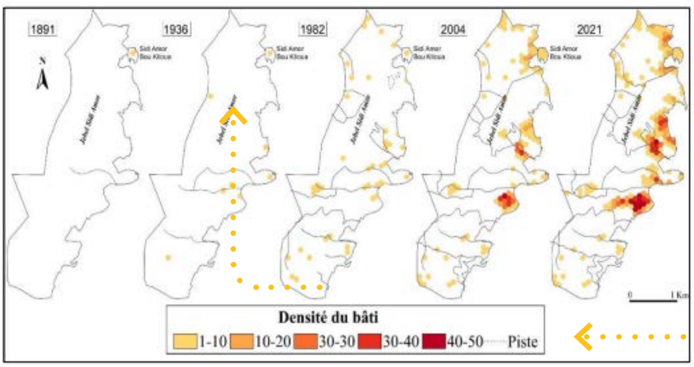
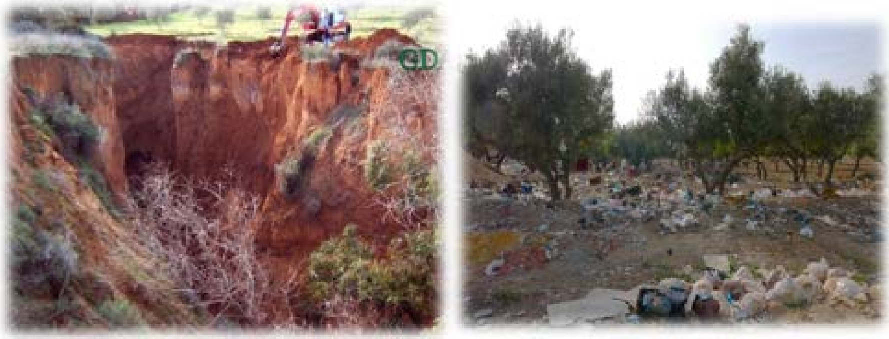


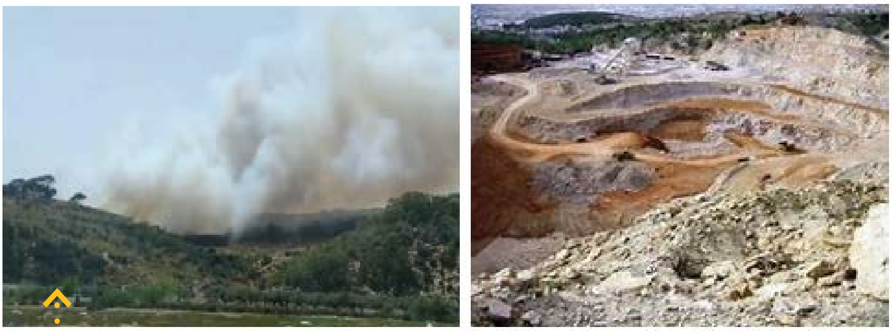
Figure 3. Changes in urban density between 1891 and 2021 in Sidi Amor

Source: Kheder, C. 2021. La zone péricentrale nord du Grand Tunis: formes d'extension urbaine et dynamiques socio-spatiales. Faculté des Sciences Humaines et Sociales de Tunis, Université de Tunis)



Erosion and landslides

Pollution



Forest fire

Quarries

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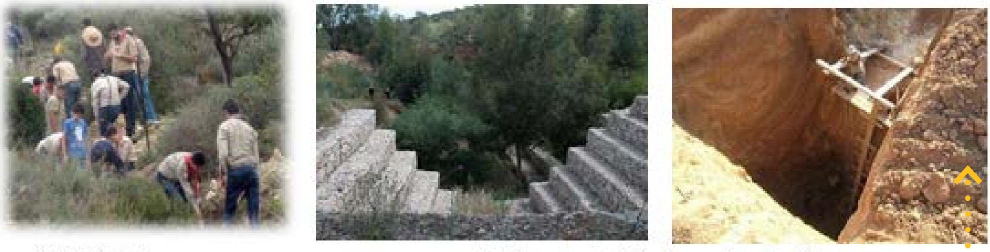
Photo 4. State of the site (degraded and abandoned) at Sidi Amor before the intervention of the GDA in 2010 (credit: GDA Sidi Amor)

Classic approaches were employed to restore a degraded landscape (e.g. reforestation, earthworks and stabilization) in order to address issues including soil erosion, gullying, agricultural abandonment, forest fragmentation, fire damage and urban invasion, etc.).



Reforestation

Earthworks, stabilization and restoration

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Photo 5. Restoration work on a degraded landscape at Sidi Amor (Source: GDA Sidi Amor)

Beyond landscape restoration, an innovative approach aimed at creating new ways of making the most of local resources, including waste: agroforestry, architecture and eco-construction, arts and crafts workshops and, ultimately, entering into ecological and cultural tourism. As a project incubator and a platform for experimentation and demonstration in support of all these projects, the Sidi Amor eco-village for arts and crafts was set up.

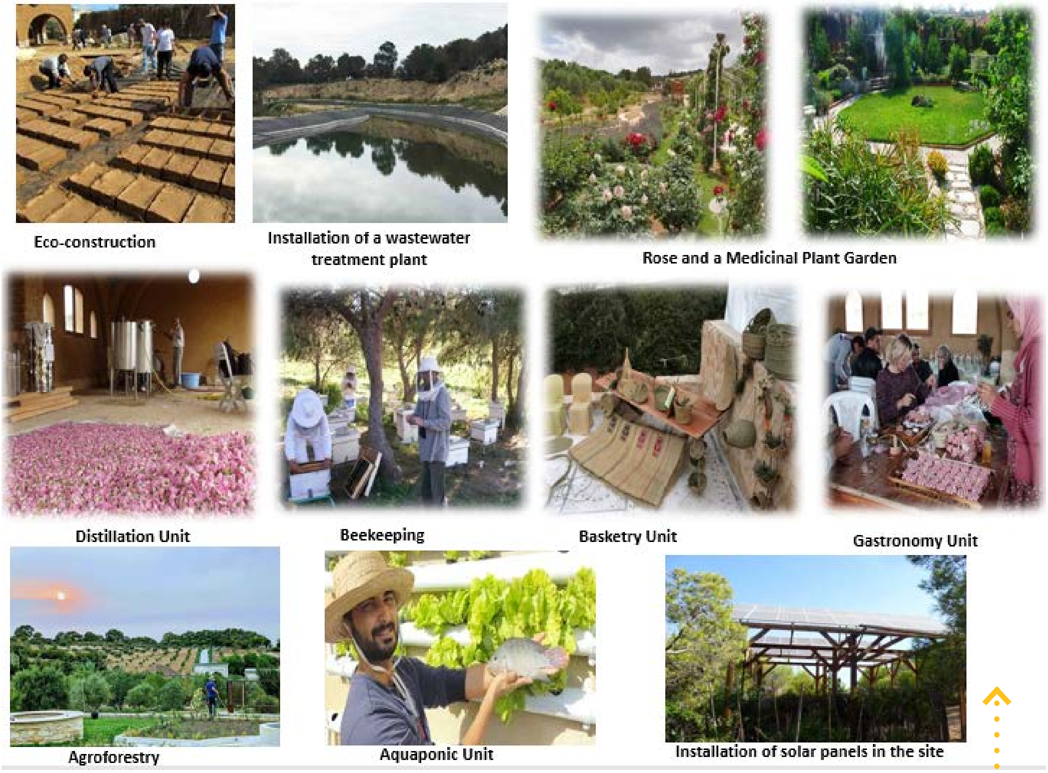
Eco-construction
Installation of a wastewater treatment plant
Rose and a Medicinal Plant Garden
Distillation Unit
Beekeeping
Basketry Unit
Gastronomy Unit
Agroforestry
Aquaponic Unit
Installation of solar panels in the site

Photo 6. Developing the ecosystem values of the peri-urban forest of Sidi Amor (Source: GDA Sidi Amor).

© Sondes Fkiri

Three key elements characterize the Sidi Amor peri-urban forest development approach:

1. Environmental requirements: The GDA considers ecology to be a social and economic imperative and not a trend reserved for the elite. All the actions contribute to protecting natural ecosystems and safeguarding the environment.

2. Networking: The GDA has developed active partnerships and networks (with national and international scientific and technical institutions, ministerial departments, associations and trade bodies, among others).

3. Creation of socioeconomic activities: These are aimed at youth and women on the site, through the use of local materials and products (e.g. eco-construction, innovative use of aromatic and medicinal plants). This project provides a source of economic income for the town's women through the development of products and services from the peri-urban forests of Sidi Amor.

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Photo 7. GDA Sidi Amor – networking for urban and peri-urban forestry (Source: GDA Sidi Amor)

© Sondes Fkiri

Prix d'Excellence
LES PRODUITS MÉDAILLÉS
CONCOURS TUNISIEN DES PRODUITS DU TERROIR
ميدالية ذهبية
Medaille D'OR
Jus de Caroube

Photo 8. The women who are part of the project are leaders and have won gold medals at international events by promoting GDA's local products (Source: GDA Sidi Amor)

In conclusion, participatory and integrated urban forest projects offer essential benefits in the fight against climate change and in improving the quality of life in cities. They need to be replicated in other cities to maximize their benefits and create sustainable environments. Collaboration between local players, political decision-makers and communities is crucial to ensure the success of these initiatives. It is therefore essential to mobilize the necessary resources and share knowledge to promote the establishment of integrated urban forests.

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FTDES. 2022. Forêts tunisiennes : Entre marginalité territoriale et valorisation des ressources naturelles. Regards croisés entre gestionnaires et usagers, Cahier n°6.

Kheder, C. 2021. *La zone péricentrale nord du Grand Tunis: formes d'extension urbaine et dynamiques socio-spatiales*. Faculté des Sciences Humaines et Sociales de Tunis, Université de Tunis. 487 pp + annexes.

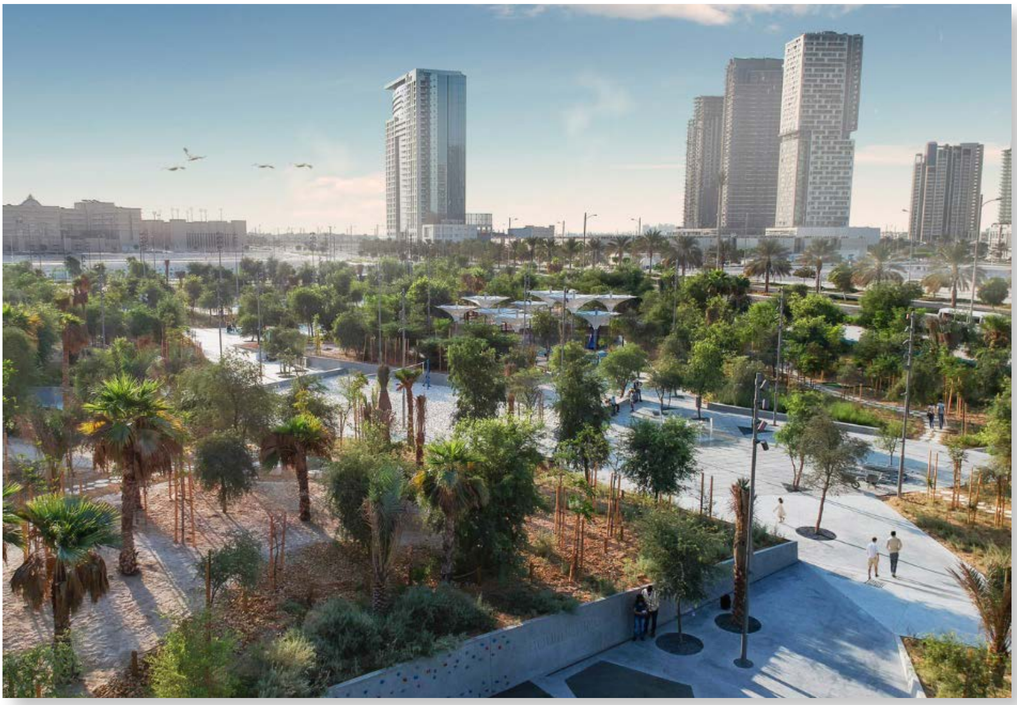
Kheder, C. & Samaali, H. 2022. Mutations de l'espace forestier: entre intégration et mise à l'écart des dynamiques en œuvre. Exemple de la forêt périurbaine de Sidi Amor (Ariana). *Cahiers du FTDES*, No. 6: 108–128. **https://ftdes.net/rapports/cahier6khedhersamaali.pdf**

5.7 Al Fay Park – a paradigm shift in urban forestry in the United Arab Emirates

The United Arab Emirates (UAE) has been witnessing rapid urbanization and development in recent years. As cities grow denser, the need for urban green spaces becomes increasingly important to enhance the quality of life for residents. Historically, the emphasis on urban development in the UAE has been on iconic buildings and infrastructure, often neglecting the integration of nature and greenery into urban landscapes (Alawadi, 2017). However, a new era of urban forestry is emerging in the UAE, exemplified by Al Fay Park in Abu Dhabi.

The case study – Al Fay Park

Al Fay Park is a 27 500 m^2 public park created in 2021 in downtown Abu Dhabi that represents a paradigm shift in how nature is incorporated into the dense megacities of the Near East. Designed by a Danish nature-based design studio, the park aims to prioritize inclusive nature over iconic structures.



© Philip Handforth

The design of Al Fay Park is based on extensive research conducted by SLA's in-house biologists and planting experts. Their studies focused on the unique nature and wildlife of the UAE, resulting in a comprehensive plant book covering all native plant species and their optimal growing conditions. Over 2 000 native trees and bushes, including the national ghaf trees (*Prosopis cineraria*), were integrated into the park. These trees were replanted from desert nurseries, contributing to increased biodiversity and natural cooling throughout the area. The park's microclimate design helps reduce traffic noise and temperature, fostering a distinct forest-like environment. Sloping entrances are strategically designed to channel the cooler southern breeze into the park, while local grasses and bushes minimize sand infiltration.

© Philip Handforth

The park's ecological design has multiple benefits for both the environment and society. It significantly reduces water consumption, utilizing recirculated water for irrigation and decreasing water usage by 40 percent compared to conventional parks. Additionally, the use of native plant species attracts pollinators, birds and other wildlife, creating a lively atmosphere in the heart of Abu Dhabi.

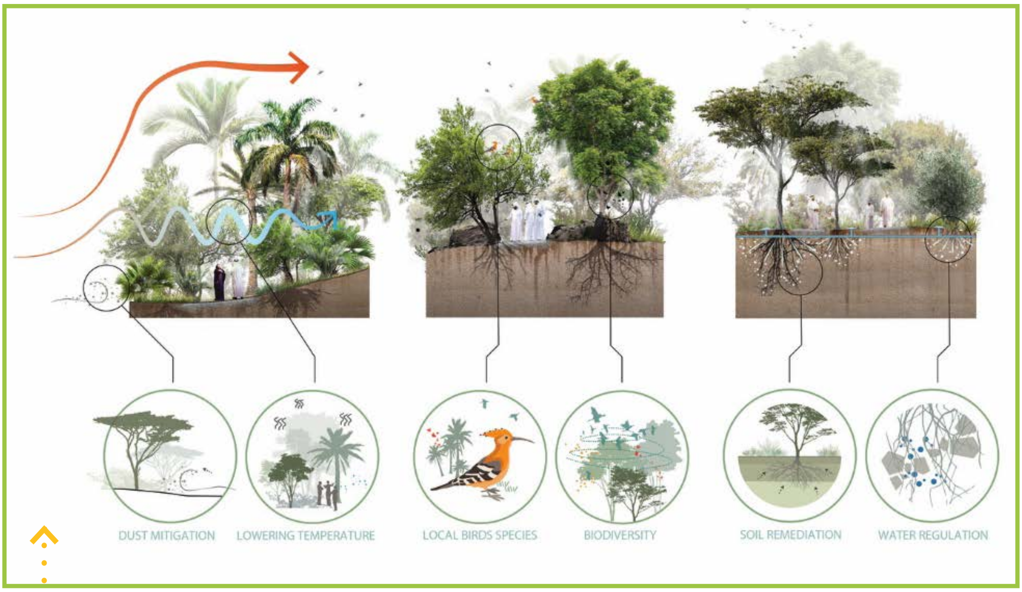
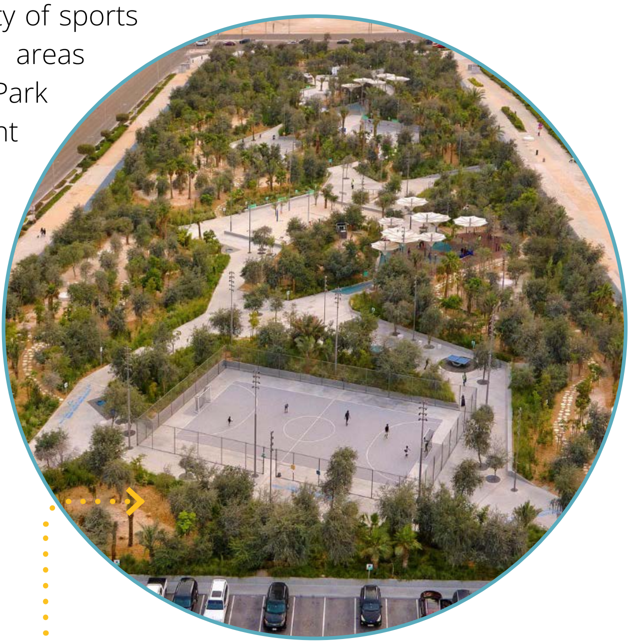

DUST MITIGATION
LOWERING TEMPERATURE
LOCAL BIRDS SPECIES
BIODIVERSITY
SOIL REMEDIATION
WATER REGULATION

Figure 4. Microclimate diagram. Credit: SLA © (https://www.sla.dk/studio/)

Al Fay Park is the UAE's first biodiversity park and sets a new benchmark for urban forestry in the country. Its goals and methods revolve around maximizing climate action, improving biodiversity, and enhancing the overall quality of life for residents and visitors. The park not only showcases the successful integration of urban green spaces, but also provides a unique social ecosystem. With a variety of sports facilities, playgrounds, fitness areas and food trucks, Al Fay Park fosters social engagement and community interaction. Furthermore, the optimized microclimate design ensures a comfortable and inviting environment for leisure activities, making the park a popular destination for people of all ages.



© Photos courtesy of Philip Handforth

By prioritizing biodiversity, sustainable practices and inclusive public spaces, Al Fay Park serves as an inspiration for future projects in the UAE and beyond. Its success demonstrates that investing in urban green spaces not only benefits the environment, but also contributes to the well-being and happiness of residents. As the UAE continues to evolve, the integration of nature and greenery will play a vital role in creating sustainable and liveable cities for generations to come.

5.8 The way forward

Efforts have been made to integrate green infrastructure into urban development in the NENA region. However, several challenges and barriers still need to be overcome. The region faces the dual challenges of a rapidly growing population and a dry, hot climate heavily reliant on fossil fuels. Consequently, the NENA has become a significant contributor to climate change and faces complex challenges in achieving urban sustainability. Moreover, the lack of data from literature, and a shortage of local expertise and technical capacity in the implementation of green infrastructures further complicate the delivery of ecosystem services in urban areas.

To move forward, it is essential to embrace sustainable urban design principles that are culturally and contextually relevant. The implementation of sustainable strategies should consider the specific challenges posed by the harsh, desert-like environment and the cultural beliefs and preferences of the local population. It is important to strike a balance between a city's compactness and functionality, ensuring that dense developments are also diverse, integrated and accessible (Alawadi, 2017). In this context, integrating climate-appropriate designs and green spaces into the urban fabric is crucial for creating sustainable neighbourhoods. To achieve this, decision-making should become more inclusive and transparent, involving academics, experts and residents in the analysis of urban challenges and green infrastructure implementation. An inclusive approach that considers the interests and needs of all stakeholders is vital for a greener urban development.

Efforts should also be focused on developing local expertise in urban forestry, incorporating both external knowledge and the resources available in the local environment. This involves fostering collaboration with experts from various disciplines and regions to share experiences, best practices and innovative ideas. By combining local knowledge with external expertise, cities can create solutions that are well-suited to their specific contexts and challenges.

With the presented case studies, cities in the initial stages of addressing sustainability can learn from neighbouring countries that share similarities and take a proactive approach in this field.

For instance, the experience in Cairo highlights how the implementation of urban farming can be a response to the loss of green spaces while promoting environmental sustainability awareness and fostering community cohesiveness. The creation of mini-forests in Amman using the Miyawaki method from Japan exemplifies the immense benefits that arise from the cross-pollination of ideas. This inspiring approach demonstrated how even distant countries can learn from each other while preserving the cultural identity associated with the local "wilderness". The experience in Tunisia illustrates the benefits of adopting a participatory and integrated management approach to preserve and develop peri-urban forests, while providing economic benefits to the community. Lastly, Al Fay Park's ecological design, based on extensive research on native plant species, demonstrates the importance of local knowledge in implementing smart green infrastructure that reduces water consumption, attracts wildlife and creates comfortable microclimates.

These examples provide tangible proof of the immense potential that green infrastructure holds for promoting sustainable urban development in NENA countries. By learning from regional experiences, cities in the NENA region can gain insights into selecting appropriate technologies and designs that consider regional contexts and physical capabilities.

Overall, the way forward for urban forestry in the NENA region involves adapting and implementing green infrastructure while considering the unique cultural, political and environmental contexts of cities. By addressing the current challenges and capitalizing on the opportunities offered by green infrastructure, climate vulnerability can be transformed into models of sustainability and resilience with an approach that not only addresses the immediate needs, but also provides long-term benefits for the environment and the well-being of communities (FAO, 2022b).

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6

URBAN FORESTS: A PERSPECTIVE FROM SUB-SAHARAN AFRICA

“A collective effort towards sustainable urban ecosystems”

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URBAN FORESTS: A PERSPECTIVE FROM SUB-SAHARAN AFRICA

6.1 Introduction

In an increasingly urbanized world, the importance of Urban and peri-urban forestry (UPF) is gaining recognition in the context of global sustainability initiatives. FAO held the **1st African Forum on Urban Forestry** in July 2021, aiming to promote greener, healthier and happier cities and towns in sub-Saharan Africa (SSA). This forum aligns with various international, regional and national science-policy initiatives, such as the **UN Decade on Ecosystem Restoration**, the **Great Green Wall**, and the **Tree Cities of the World** programme, which seek to scale up urban forestry and ensure its sustainable management (Berglihn and Gómez-Baggethun, 2021).

Despite the increasing attention given to urban forestry in SSA, there is a lack of comprehensive studies on its state in the region. Therefore, in the run-up to the **2nd World Forum on Urban Forests** to be held in October 2023, this chapter seeks to appraise the extent and dynamics of urban forestry in SSA. It begins by providing an overview of the trends in the region, highlighting specific ecosystem services that are particularly significant, prominent or distinct in SSA. The chapter then explores innovative practices in urban forestry within SSA. Finally, it discusses future opportunities for resourcing and research in the field.

6.2 The context of urban forestry in SSA

To appraise the extent and dynamics of urban forestry in SSA, it is necessary to first appreciate the contexts in which it occurs. This is because, at a continental scale, SSA is characterized by a complex array of social, climatic, environmental and economic dynamics that influence or shape the planning, management and implementation of urban forestry, as well as citizens' needs and expectations of urban forests and trees in urban spaces. SSA encompasses 46 countries, spanning 47° of latitude (from approximately 13° North to 34° South), from deserts to tropical forests and a GDP per capita range (in 2021) of USD 220 in Burundi to approximately USD 8 600 in Gabon (World Bank, 2021). This diversity leads to a wide range of urban forestry policies, initiatives, needs, financing, expertise, coverage and driving forces, making it challenging to generalize across the region.

One major dynamic shaping urban planning and services in SSA, including urban forestry, is the high rate of urban population growth (Figure 1). It is expected to increase from 609 million in 2021 to 772 million by 2026, and 1.26 billion (UNDESA, 2019) or an additional 950 million people by 2050 (OECD-European Commission, 2020). Current urban growth rates (2020–2025) in SSA are more than double those of Asia and three times that of Latin America and the Caribbean (UN-Habitat, 2022). there isn't enough space between the words in countries of the Global North (Shackleton *et al*., 2021). Urban growth is driven in part by large-scale rural to urban migration, internal population growth and urban expansion enveloping surrounding rural villages and landscapes. This growth puts significant pressures on undeveloped lands, demands for basic services and the ability to plan and implement effective strategies. Consequently, urban forests often experience declines, leading to the loss of tree canopy, with adverse effects on water reserves and biodiversity while exacerbating natural hazards such as landslides, flooding and coastal erosion (Pastore, 2022; Zabret and Šraj, 2015; Girma *et al*., 2019; Thorn *et al*., 2021a). For instance, Freetown in Sierra Leone lost 12 percent of its total canopy between 2011 and 2018 due to population expansion and rapid urbanization, and many other cities experienced similar declines.

The spatial extent of urban forests in SSA is largely unknown, but it is evident that the current space allocated for urban trees is limited. In general, urban spatial configurations are designed to accommodate dense human populations, movement and social interactions. As a consequence, this leaves limited room for retrofitting green strategies. For example, it is difficult to reduce stormwater runoff by 50 percent using green infrastructure in a city that is 90 percent impervious, particularly if only 1–2 percent of the land surface can be allocated to greening strategies (Pataki *et al*., 2021).

Informal settlements or slums, which account for 58–75 percent of residential areas in SSA, have grown rapidly over the last three decades (Visagie and Turok, 2020). They face pervasive poverty, inequality and a limited provision of basic services (UN-Habitat, 2022). In these contexts, urban green spaces play crucial roles in providing land for dwellings, food production and various provisioning services such as fuelwood, construction timber, fodder, wild foods and traditional medicines (Wijesinghe and Thorn, 2021; Mollee, Pouliot and McDonald, 2017; Shackleton *et al*., 2022). However, the extensive use of local provisioning services may lead to unsustainable practices, overextraction (fuelwood demand is often implicated), land degradation, dumping of household, sanitary or commercial waste, and informal housing (Adegun, 2018). Budget constraints and restricted capacities lead to limited or no maintenance of urban green spaces, with them being often under-prioritized in spatial planning processes and considered non-essential luxury goods when compared to other basic services and housing (UN-Habitat, 2016; Herslund *et al*., 2018). Due to the extensive use of provisioning services, local ecological knowledge of species is high, which is also a consequence of many residents being migrants from rural areas, or only first-generation urban dwellers.

Informality extends beyond housing and the economy to encompass the nature of many urban forests and green spaces. Thus, there are typically many green areas in SSA towns and cities that have neither been formally designated nor managed as such, and yet they provide various ecosystem services to urban residents. These spaces include, *inter alia*, undeveloped lots, riparian fringes, railway and road verges, interstitial spaces, peri-urban commonages. Indeed, informal areas may cover a larger area than formal green spaces, especially in poorer neighbourhoods (Radebe, 2018), and therefore are more accessible. In being undesignated and often unmanaged, the spaces may be used for activities that would be regulated or disallowed in the formal urban forests and parks, such as sports, cultural or traditional ceremonies, provisioning of goods, loud or anti-social behaviour, and urban agriculture. The vegetation is typically less maintained, and thus may be more natural, which is important for certain spiritual services (Ngulani and Shackleton, 2019; Kepe, McGregor and Irvine, 2015). However, lack of maintenance and care may also encourage degrading activities (e.g. dumping), disturbance, grazing by livestock, and invasion by alien species. The unmaintained appearance might also elicit safety concerns (Manyani, Shackleton and Cocks, 2021). Nevertheless, for many urban dwellers, informal green spaces are the only green spaces within reasonable proximity to homes and places of work.

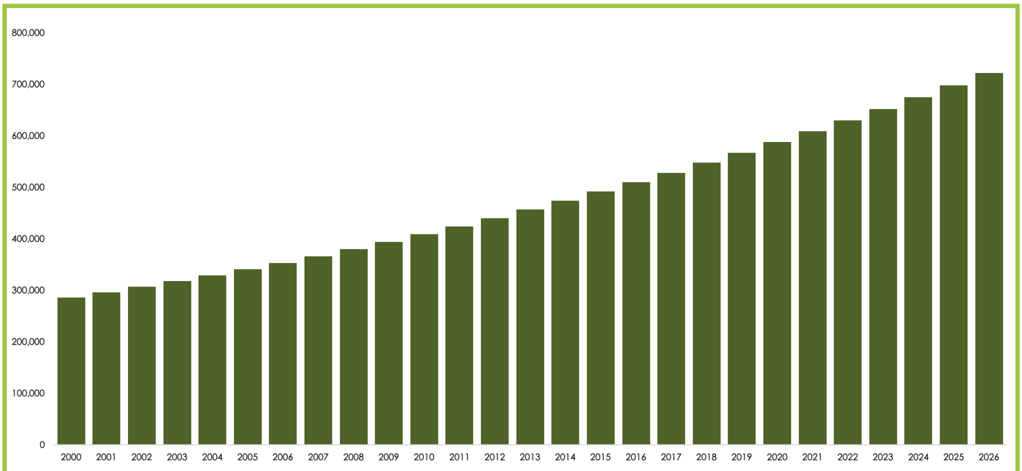


Figure 1. Number of people living in urban areas in Africa, 2000--2026 (in 1 000s) (UNDESA, 2019)

UNDESA (United Nations, Department of Economic and Social Affaairs), Population Division. 2019. World Urbanization Prospects: The 2018 Revision (ST/ ESA/SER.A/420). New York. https://population.un.org/wup/publications/Files/ WUP2018-Report.pdf

In contrast to informal settlements, former colonial residential neighbourhoods in many SSA cities and towns exhibit relative affluence, reasonable services and large gardens, resulting in a 'leafy' or green visage. Wealthier residents in these areas often invest time and funds in greening for aesthetic reasons, privacy, and even food production. Indeed, recent studies show a correlation between wealth and vegetation cover and diversity (Giombini and Thorn, 2022; Venter *et al*., 2020), although this relationship is far from universal. The urban authorities also maintain street trees and local parks, a legacy of the former colonial period in design and species, such as *Eucalyptus*, *Quercus* and *Pinus*, which are poorly adapted to the climatic conditions and compete for resources with indigenous species (Shackleton and Gwedla, 2021). However, there is a nascent move in some countries towards favouring native tree species in public urban spaces, together with the recognition for 'unmanaged green spaces' critical for pollination, maintaining healthy predator–prey relationships, grasses and wildlife connectivity. Nevertheless, the contrast in abundance of and access to urban green spaces and trees between informal and low-income neighbourhoods and more affluent ones remain an environmental justice concern (e.g. Giombini and Thorn, 2022; Venter *et al*., 2020).

Colonial legacies can also often be observed in urban master plans and regulations (Baruah, Henderson and Peng, 2021). This situation relates to a range of different aspects, including density of buildings, abundance and proximity of green spaces, and spatial zoning of neighbourhoods for different socioeconomic classes or racial groups. There are many present-day cities that simply adopted and updated old colonial plans in their entirety or modelled revisions on the original, colonial plans (Likongwe *et al*., 2021). Similarly, access to green spaces and the activities permitted in them are shaped by regulations legislated during the colonial period, which may not resonate with indigenous culture or the needs of present-day communities (Cocks *et al*., 2020).

Livestock, such as cattle, goats, sheep and camels, are commonly found in towns and cities throughout SSA (Graefe, Schlecht and Buerkert, 2008). Free-ranging grazing livestock are commonly found along roadsides and in formal and informal green spaces, while penned animals are fed fodder by their owners harvested from similar places, or via purchased feed. As a consequence, the demand for fodder affects species composition, growth rates and survival of urban trees (Shackleton *et al*., 2017). Hence, urban authorities and citizens require awareness of such pressures when selecting tree species. In addition, livestock excreta can serve as a source of manure for urban agriculture or domestic gardens (Thorn *et al*., 2021b).

A final consideration is that urban forestry is generally given a low priority by many urban authorities in SSA, particularly in contexts of high poverty and informal settlements. Municipal budgets and resources are often directed towards infrastructure development and the delivery of basic services (Gwedla and Shackleton, 2015). In such settings, authorities often do not prioritize investing in: local enforcement (e.g. to prevent dumping, open defecation); municipal budgets for waste management (e.g. fuelling waste trucks, clearing drains, preventing the overflow of stormwater drainage systems, regularly extracting sewage); security (e.g. crime, vandalism); and lighting. In addition, limited access to grid-connected or renewable energy continues the dependence on fuelwood and charcoal for cooking and heating, thereby contributing to deforestation. Regular land occupation encroaches on public green spaces, riparian areas and floodplains, steep slopes, easements and sensitive habitats.

However, the low prioritization of urban forestry by authorities typically contrast with the high appreciation of trees and green spaces by most urban citizens, resulting in citizen-led initiatives to plant or maintain trees in private and public spaces for a range of different reasons and services (Wijesinghe and Thorn, 2021; see Table 1 for a list of 60 tree planting projects in cities and towns in SSA, compiled by Ekamby and Mudu [2022]). Moreover, concerns about the possible effects of climate change are changing mindsets (and budgets) regarding the value of trees and urban green infrastructure in many regions.

6.3 Nature and magnitude of benefits from urban forests in SSA

The ecosystem goods and services from urban forestry in SSA are diverse (Hosek, 2016). Benefits extend well beyond the regulating and recreational services commonly associated with urban forestry in the Global North. For example, SSA urban contexts heavily rely on provisioning and spiritual services, which are accessed from a wide array of formal and informal green spaces under both private and public ownership.

The magnitude and importance of specific services vary depending on local socioeconomic and cultural factors, the condition of the urban forest, and the physical accessibility of these spaces. However, it is important to note that urban forests in SSA may also cause more ecosystem disservices than in other regions. This situation is primarily due to the region’s vulnerability, resulting from factors such as: poverty; people living in precarious or marginal areas; increased reliance on urban forests for provisioning services; challenges in waste management and sanitation.

Provisioning services

Fuelwood sourced from the woody biomass of trees and shrubs is a crucial provisioning service. For instance, certain tree species in Nairobi are used for heating and cooking (Furukawa *et al*., 2011). In low-income urban areas of South Africa, such as Bulawayo (Zimbabwe), about 70 percent of residents depend on fuelwood for energy (Dube, Musara and Chitamba, 2014; Shackleton *et al*., 2022). Some poorer households consume up to 3 670 kg of fuelwood annually (Shackleton *et al*., 2022), but the exact proportion sourced from urban and peri-urban forests is unknown.

Urban forests in SSA also provide food and medicines, directly from the trees themselves, as well as indirectly through mushrooms or wildlife found in these forests. Urban residents in places like Ibadan, Nigeria gather fruits from citrus species, *Mangifera indica* (mango) and *Cocos nucifera* (coconut), and utilize bark for medicinal purposes to treat malaria or arthritis (Borokini, 2012). In South Africa, low-cost and informal neighbourhoods harvest annually about 340 kg of fruit per household from their own homesteads, as well as trees in public spaces (Kaoma and Shackleton, 2015). Wild foods are also collected for subsistence and income generation (Hosek, 2016). The likelihood of urban farms for providing food depends on climatic conditions, cost and availability of water, land tenure, and security, among other factors. For instance, in Windhoek, Namibia, private landowners are more likely to grow fruit trees in their gardens than government bodies in public spaces due to the high costs of irrigation, as well as fencing to secure against theft or livestock grazing damage of tree saplings (Wijesinghe and Thorn, 2021).

In addition, urban trees serve as a valuable source of timber for construction, fencing, crafts and tools. Fibrous materials, such as palm leaves, are used for roofing, screens and crafts (e.g. Kaoma and Shackleton, 2014). Urban trees also play a role in providing fodder for animals, particularly in peri-urban areas of SSA (Thorn *et al*., 2021a).

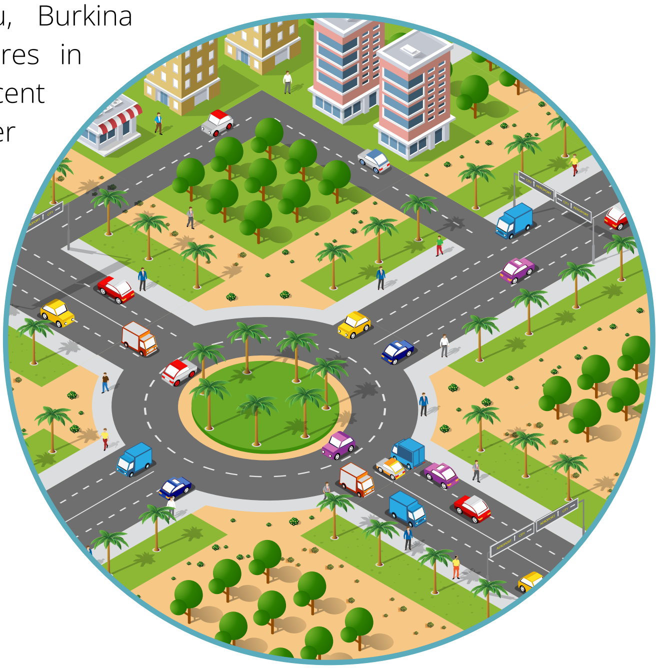
Regulating services

Urban trees play a crucial role in climate regulation, particularly in providing shade and cooling (Lawal, Lennard and Hewitson, 2019), and trapping and filtering dust, releasing oxygen, sequestrating carbon, and ameliorating air and noise pollution (UNFCCC, 2023; Hwang, Wiseman and Thomas, 2015; Tan, Lau and Ng, 2016). With climate change projections indicating greater warming and expanding aridification in SSA (due to projected declines in semi-desert, dry savanna and

Mediterranean biomes), urban trees will become more important. Furthermore, climate change will lead to changes in above-ground net primary production, soil carbon and surface runoff. In addition, climate change will likely enable invasive species expansion, which impacts biodiversity loss, and changes in the frequency and intensity of wildfire seasonality, and in turn affect seed germination, growth of young plants and water regulatory services (IPCC, 2022).

Urban forests also provide flood regulation benefits by mitigating stormwater runoff and erosion, and improving water quality through intercepting pollution. These environmental services are essential because increased urban expansion and land use and land cover change results in the infill, sedimentation, changing profile or reclamation of water sources while enlarging impermeable surface areas, thereby increasing stormwater runoff with consequent sewer overflows. For instance, in Zomba City, Malawi, the restored Sadzi Hill is key for aiding climate regulating services, such as reducing runoff and flooding accompanied with mud and rockslides (Likongwe *et al.*, 2021). Similarly, in Freetown, Sierra Leone, rehabilitated forests in hilly environments are important for preventing mudslides and sediment-laden floods during the rainy season (Ciu *et al.*, 2019).

Urban forestry also helps in reducing the urban heat island (UHI) effect, where cities are warmer than their surrounding areas due to grey infrastructure and human activities. Vegetated areas in cities have been shown to have lower temperatures than less vegetated areas. For example, in Ouagadougou, Burkina Faso, nocturnal temperatures in areas with more than 40 percent vegetation cover were lower than areas with less than 10 percent vegetation (Linden, 2011). Similarly, in Bulawayo, Zimbabwe, parks had a cooler midday temperature by 3.6 °C than surrounding built-up areas, which were 6.1 °C warmer (Ngulani and Shackleton, 2020).



Cultural services

urban forests in sub-Saharan Africa (SSA) provide important cultural services to local communities, including spiritual and religious values, recreation, and a sense of place. Values related to sacred natural places, where one might feel reverence for nature, are often crucial in connecting residents and places, especially in modern multicultural and multifaith societies (Rall *et al*., 2017). However, these services are often overlooked in urban forestry design, planning and management (Konijnendijk *et al*., 2018).

Although only a handful of studies have documented the spiritual and cultural attachments to urban nature in SSA (De Lacy and Shackleton, 2017; Murtala and Manaf, 2019; Ngulani and Shackleton, 2019; Seburanga *et al*., 2014), it has been found that the spirituality linked to nature holds high importance in certain cities such as Cape Town (South Africa), Bulawayo (Zimbabwe) and Kumasi (Ghana) (Rall *et al*., 2017). This situation contrasts with findings in the Global North, where spiritual values have been ranked lowest in importance compared to other cultural services such as recreation.

Some tree species serve as a connecting medium between people and their ancestors (Shackleton *et al*., 2015; Likongwe *et al*., 2021). For instance, certain tree species, such as the strangler fig (*Ficus thonningii*) and the coral tree (*Erythrina abyssinica*) in Rwanda, are regarded as spiritual mediators, while others such as the northern large-leaved dragon-tree (*Dracaena steudneri*) are believed to repel ghosts. These species are associated with residential designs throughout the country (Seburanga *et al*., 2014). Trees can also be associated with shrines or worship, where the choice of tree species planted considers their social, cultural and spiritual values (Fuwape and Onyekwelu, 2011), in addition to their nutritional and aesthetic benefits (Oyebade, Popo-ola and Itam, 2013; Babalola *et al*., 2013). Indeed, de Lacy and Shackleton (2017) have demonstrated a correlation between tree species richness and a sense of spirituality in urban sacred sites.

Urban forests in SSA also provide spaces for quiet reflection, which is crucial in high-stress urban environments. For instance, in Kigali, Rwanda, the Nyandungu urban-rehabilitated wetland incorporates the Pope's Garden and a medicinal garden with 17 000 trees comprising 55 indigenous tree species (Photo 2). Urban forests are gathering places for various events, including weddings, ceremonies, meetings and political rallies, and as such they promote social inclusion, community building, education and knowledge sharing. Additionally, they offer opportunities for exercise, sports and children's play.

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Photo 2. A beautiful setting in Kigali: Nyandungu wetland is a newly opened green space featuring intentionally planted native tree species, the garden of Pope John Paul II, and a medicinal garden.

6.4 Trends and innovations emerging in urban forests across SSA

Urban forests and people's relationships with them are dynamic and constantly changing through time and in place. Hence, this needs to be considered by urban planners, authorities and forestry and parks departments. We briefly consider some of the trends and innovations evident in one or more SSA regions.

Planning partnerships between local governments and the public

Efforts to expand urban canopy cover are gaining momentum at the city level as authorities become increasingly aware of the links between climate change, nature-based solutions, critical infrastructure and essential public services. For instance, in Kampala, Uganda, a 20-year urban forestry plan (2019–2039) has been produced to expand urban tree density, increase the canopy cover from 15 percent to 30 percent, boost native tree species diversity, raise community understanding of city urban forest management, and create an online spatially explicit tree directory for the public to find information on the 328 species in private and public spaces (**www.kcca.go.ug/tree-directory**). Despite these efforts, finance, staffing, equipment, population expansion, land competition and rapid construction of roads and other grey infrastructure remain major bottlenecks.

In 2017, following a devastating landslide in Freetown (Sierra Leone) that left more than 1 000 people dead or missing, the "**Transform Freetown"** initiative was launched. As part of this initiative, the "Freetown the **TreeTown Campaign**" aimed to grow one million trees and increase the city's vegetation cover by 50 percent by the end of 2022. The campaign encouraged community ownership, in particular, getting residents in low-income areas along slopes and rivers to take part in tree planting and maintenance. Freetown implemented an innovative financing model, leveraging blended sources of finance and digital technology. Accordingly, the TreeTracker app was introduced to monitor the survival of planted seedlings (targeting 80 percent), with participants receiving mobile money as an incentive. Each tree was assigned a unique geotagged and photographed ID, which could be turned into 'impact tokens' that businesses and individuals could buy, sell and trade to fund further tree planting.

These examples demonstrate the importance of planning partnerships between local governments and the public in promoting urban forestry, and highlight the potential for innovative financing and digital solutions to support tree planting and maintenance initiatives.

Participatory urban planning and development

Participatory planning advocates for a bottom-up approach in developing strategies for urban green infrastructure that reflect contemporary realities and the direct involvement of municipal departments (FAO, 2016). Although SSA has been slow to successfully implement these principles, nevertheless, several cities are making progress. For example, the master plan of Kampala, Uganda was recently revised by the Kampala Capital City Authority using participatory urban natural asset mapping in order to identify the location, condition and vulnerability of urban natural assets, as well as target spaces for urban forestry (Figure 2) in the Greater Kampala Metropolitan Area.

In Cape Town, South Africa, tree removals in public spaces or road reserves only occur where there is an unmanageable threat to human life or interference with overhead or underground services (City of Cape Town, 2021).

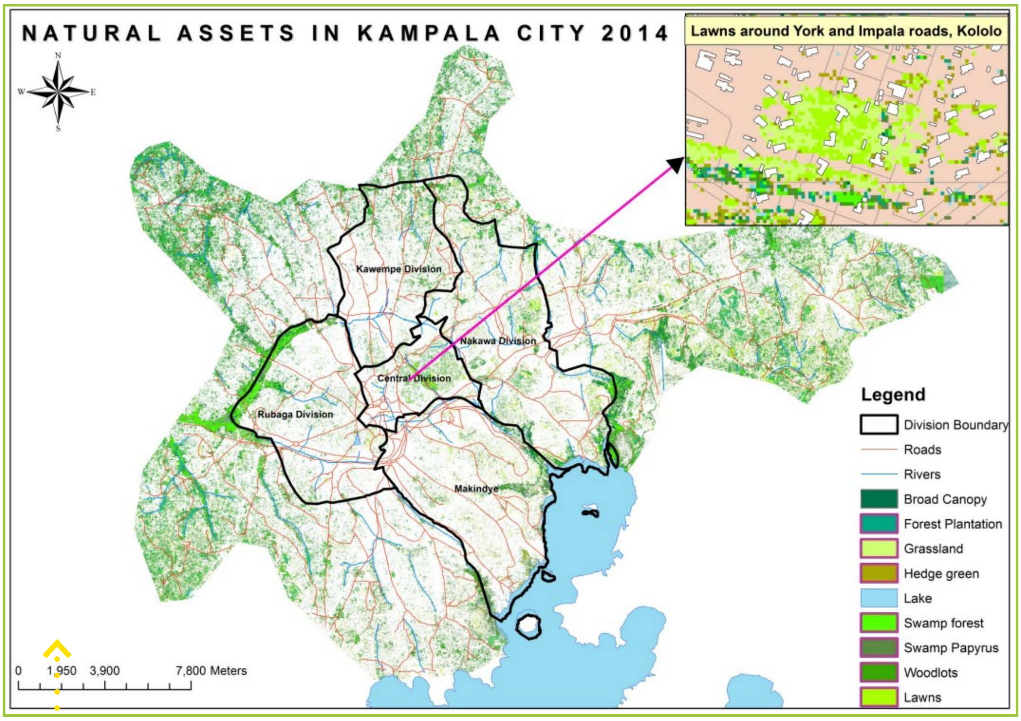
NATURAL ASSETS IN KAMPALA CITY 2014
Lawns around York and Impala roads, Kololo
N
W
E
S
Kawempe Division
Nakawa Division
Central Division
Rubaga Division
Makindye
Legend
Division Boundary
Roads
Rivers
Broad Canopy
Forest Plantation
Grassland
Hedge green
Lake
Swamp forest
Swamp Papyrus
Woodlots
Lawns
0 1,950 3,900 7,800 Meters

Figure 2. Urban natural asset mapping using participatory methods in Kampala, Uganda (ICLEI Africa, 2019) Source: ICLEI Africa. 2019. Urban Natural Assets for Africa: Rivers for Life. https://cbc.iclei.org/project/una-rivers-life

In Sekondi-Takoradi, Ghana, various organizations (e.g. Goshen Global Vision, Forestry Commission of Ghana, Department of Parks and Gardens, United States Department of Agriculture) launched the Greening Sekondi-Takoradi project. Students, churches, community members and other stakeholders planted 20 000 trees in degraded spaces in Sekondi-Takoradi to ensure even distribution and fair access to green infrastructure (Goshen Global Vision/USDA-Forest Service, 2019). Despite these examples, most initiatives that plant urban forests focus on distributive justice,[1] namely the socially just allocation of resources, goods and opportunities in a society rather than recognizing and addressing aspects of urban forestry such as recognitive[2] and substantive justice[3] (Wijesinghe and Thorn, 2021).

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[1] Distributive justice concerns the socially just allocation of resources, goods and opportunities in a society. It is concerned with how to allocate resources fairly among members of a society, taking into account factors such as wealth, income and social status.

[2] Recognition justice is a theory of social justice that emphasizes the recognition of human dignity and of the difference between lower status groups and the dominant society.

[3] Substantive justice is the justice administered according to the rule of law.

These examples demonstrate the importance of involving municipal departments responsible for urban green infrastructure in decision-making and incorporating participatory approaches for successful implementation. The need for recognizing and addressing justice considerations in urban forestry projects is also highlighted.

Urban agriculture including horticulture and agroforestry

The participation of households in urban agriculture in SSA varies across countries, ranging from as low as 4 percent in Windhoek, Namibia (Thorn *et al*., 2021a), to 33 percent in Zambia and Kenya, and as high as 72 percent in Lubumbashi, Democratic Republic of the Congo (Balasha, Murhula and Munahua, 2019). Barriers such as settlement formality, property rights, and distance from food retailers (Davies *et al*., 2021) and the cost of irrigation in arid regions (Wijesinghe and Thorn, 2021) contribute to the differences in participation rates. Urban agriculture offers numerous benefits, including increased food security for the urban poor, protection of urban ecosystems, community cohesion, education, and closing energy and mass loops in a circular economy[4] (Kanosvamhira and Tevera, 2022; Balasha, Murhula and Munahua, 2019; Ferreira *et al*., 2018).

In East and Southern Africa, urban agriculture activities are predominantly conducted by women, while in West Africa, both women and men are involved (Drechsel, Hope and Cofie, 2013). Fruit trees, particularly mango (*Mangifera indica*), are commonly found in urban households in countries such as United Republic of Tanzania, Zanzibar (FAO, 2014), Democratic Republic of the Congo (Sikuzani *et al*., 2019), Nigeria (Dangulla *et al*., 2020) and Zimbabwe, and throughout Southern Africa (Shackleton and Mograbi, 2020). Horticultural production is mainly practised in backyard spaces, unlike designated urban areas as seen in Europe and the United States of America.

Alongside urban agriculture, multistorey, mixed agroforestry systems have a long history in Africa for generations, supporting the cultivation of fruit, coffee, spices, and other crops. Agroforestry systems diversify the income of investors and growers and minimize risks against commodity price fluctuations while generating intermediate revenues from understorey crops to help service the loans required for investing in tree planting and the wait for longer-term investments from trees (Mengesha *et al.*, 2020).

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[4] A circular economy seeks to close the loop on resources by reusing and recycling energy and raw materials.

State-led river and landscape restoration using urban forestry

Several projects across SSA utilize urban forestry to protect watersheds, which has various benefits such as flood prevention, maintaining healthy reservoirs, reducing the UHI effect, limiting evapotranspiration, intercepting pollutants, and ensuring food security for urban and downstream households that rely on fish as a nutrient source.

In West Africa, numerous initiatives focus on restoring riparian areas and slopes. Many cities in Nigeria, for example, are planting trees in erosion-prone areas to enhance water percolation and reduce runoff. Similar efforts are taking place in Ghana, Côte d'Ivoire, Benin and Togo, where trees are planted along steep slopes to mitigate gully erosion (Conigliaro, Borelli and Salbitano, 2014).

In East Africa, the **Nairobi Rivers Basin Rehabilitation and Restoration Program** aims to enhance the quality of drinking water and the city's water supply, improve

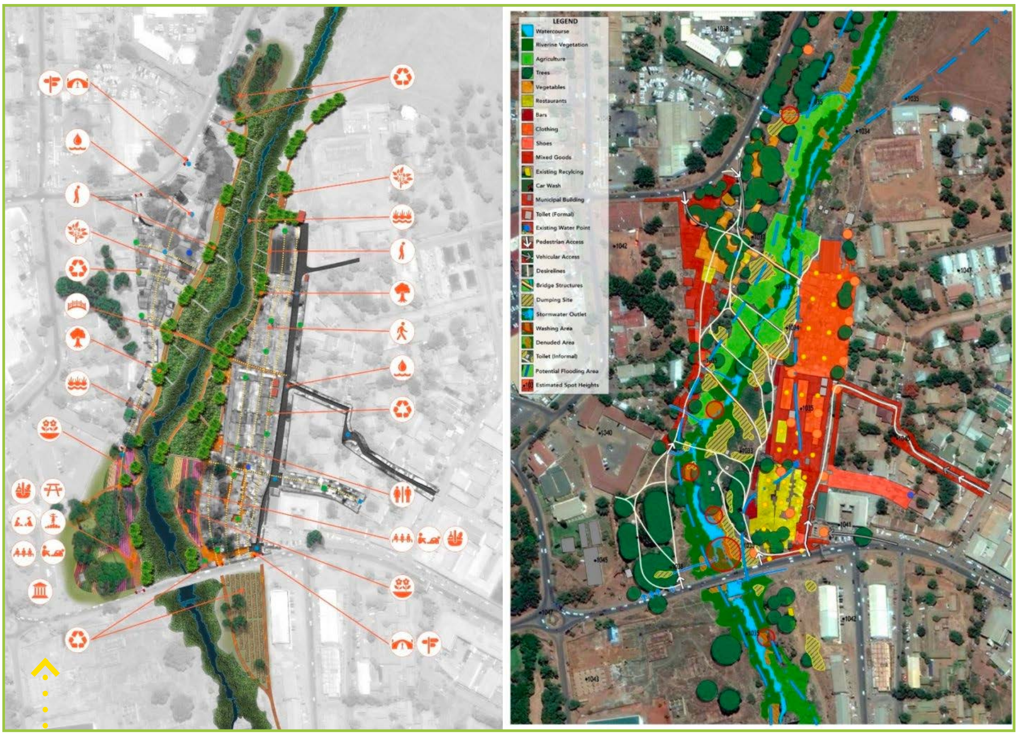
LEGEND
Watercourse
Riverine Vegetation
Agriculture
Trees
Vegetables
Restaurants
Bars
Clothing
Shoes
Mixed Goods
Existing Recylcing
Car Wash
Municipal Building
Toilet (Formal)
Existing Water Point
Pedestrian Access
Vehicular Access
Desirelines
Bridge Structures
Dumping Site
Stormwater Outlet
Washing Area
Denuded Area
Toilet (Informal)
Potential Flooding Area
Estimated Spot Heights
•1040
•1042

Figure 3. Landscape master plan in Lilongwe, including tree planting along the river.
Source: ICLEI Africa. 2021. Lilongwe River Revitalisation project.
https://cbc.iclei.org/river-revitalisation-lilongwe-malawi/site-analysis

wastewater treatment processes and reduce runoff. Rehabilitation programmes are underway in three peri-urban settlement river catchments in Kiambu County, which bounds the northern border of Nairobi. Likewise, in Dar es Salaam, United Republic of Tanzania, Zanzibar, the **Msimbazi Basin Development Project** focuses on rehabilitating a flood-prone basin, encroached by settlements. These projects involve investment in urban forestry, terracing, sediment and erosion control, solid waste management, transport and urban planning. Furthermore, urban forestry is important for filtering industrial and household waste, mitigating waterborne diseases such as cholera and typhoid, and redressing issues such as the impacts of sand mining.

In Lilongwe, Malawi, river revitalization is being implemented through urban forestry in collaboration with the **Lilongwe City Council, ICLEI Africa** and the Tsoka and Lizulu informal markets in Lilongwe (ICLEI Africa, 2021). Risk hotspots along river buffer zones have been identified, urban agriculture is being implemented, waste dumping is being reduced, and a landscape master plan has been developed (ICLEI Africa, 2019) (Figure 3).

Municipal-led programmes to plant indigenous species

The species composition of urban forests varies in African cities, with some cities dominated by exotic species and others having a higher abundance of native species. This situation in turn impacts the kind and extent of benefits accrued (Aronson *et al*., 2014). In cities such as Kigali in Rwanda, Lomé in Togo, Kumasi and Accra in Ghana, Maradi and Niamey in Niger, and many South African towns, exotic or alien species predominate (Nero, 2019; Gwedla and Shackleton, 2017; Moussa *et al*., 2020; Seburanga *et al*., 2020). For instance, in ten South African towns, 71 percent of the street tree species are exotic (Gwedla and Shackleton, 2017). Similarly, in Kigali, Lomé and Niamey, exotic species constitute about 75 percent, 69 percent and 52 percent of the woody species composition, respectively (Moussa *et al*., 2020; Seburanga *et al*., 2020).

Many exotic species were introduced into African cities during the colonial era and were mostly planted along streets, in parks and homesteads for shade, beautification and economic development (Hosek, 2022; Shackleton and Gwedla, 2021; Seburanga *et al*., 2020). Some of the introduced species have become invasive in many countries, spreading from urban settings into the surrounding rural farmlands and conserved areas, threatening biodiversity and ecosystem functioning. Some common exotic species in African cities include jacaranda (*Jacaranda mimosifolia*), Madagascar almond (*Terminalia mantaly*), casuarina (*Casuarina equisetifolia*), royal palm (*Roystonea regia*), avocado (*Persea americana*), common guava (*Psidium guajava*), mango (*Mangifera indica*), neem (*Azadirachta indica*), false ashoka (*Polyalthia longifolia*) and cassia (*Senna siamea*).

In other cities, native species richness exceeds that of exotic species (Chimaimba *et al*., 2020; Dangulla *et al*., 2020). In the Nigerian cities of Sokoto and Zaria, urban farmlands have a higher abundance of native species (Dangulla *et al*., 2020). In Zomba, Malawi, 64 percent of tree species are indigenous, with higher proportions in remnant patches of vegetation than in gardens or planted areas (Chimaimba *et al*., 2020).

Native species have the potential to be cultivated as amenity and avenue trees in urban areas just as successfully or even better than exotics, since they are better adapted to the local environments. Indigenous species are already well-known to urban dwellers and may be ecologically and economically preferred, as well as supporting more native fauna and flora (Shackleton, 2016). Furthermore, indigenous species reduce the susceptibility of urban forests to unsuspecting environmental disasters (i.e. pests and diseases). In addition, native species serve as a haven for threatened and vulnerable species, for example, baobab (*Adansonia digitata*), African mahogany (*Afzelia africana*), mahogany (*Entandrophragma* spp.), *Hymenostegia aubrevillei*, African mesquite (*Prosopis africana*) and black afara (*Terminalia ivorensis*) (Nero *et al*., 2018; Chimaimba *et al*., 2020). Moreover, planting native species can help preserve the cultural and sacred values attached to some species (Atindehou *et al*., 2022).

However, native species have been under-represented in many African cities due to a lack of knowledge about their ecology and maintenance, and preferences for exotics. Nevertheless, there is a growing emphasis on planting native species, with the growing recognition of the above-mentioned benefits. For example, new parking lots at shopping centres in South Africa are now dominated by the planting of native species (O'Donoghue and Shackleton, 2013), while plant nursery owners report increasing demand for indigenous species by consumers (Arnoldi and Shackleton, 2021).

Community hillside rehabilitation to reduce erosion

Beyond city-wide urban planning and programming across SSA, local actors (e.g. community groups, organizations, businesses) play an integral role in the planting and management of urban trees, particularly where municipal interventions may be limited. Hillside rehabilitation and improved management by communities are important not only in reducing erosion, but reducing hazards such as mud and rockslides, and increasing native fauna and flora. For instance, Zomba, Malawi is endowed with six hills, most of which are deforested. Residents living around Sadzi Hill, which was one of the heavily degraded hills following encroachment from over 350 crop gardens and settlements, experienced erosion and mud and rockslides in the rainy season (Chimaimba *et al*., 2020). Since 2013, local individuals have championed regeneration and replanting of the Hill. As a result, vegetation cover has increased from 26 percent to 61 percent, with an almost threefold tree density compared to the nearby hill with no co-management, and with a concomitant decrease in the incidence of mudslides (Likongwe *et al*., 2021).

Roadside nurseries providing planting stock

A common use of roadside urban forests in major SSA cities is the shelter they provide to small-scale, entrepreneurial nurseries that supply trees to residents, businesses and local authorities. The roadside location also makes the nurseries and plants for sale visible and accessible to motorists and pedestrians. Together with significant employment, the income earned is generally above the national poverty lines. For example, in Ethiopia, Molla, Abtew and Tebkew (2020) calculated net annual incomes as USD 14 628 per nursery, while they were reported as being somewhat lower in Kenya, at USD 9 474 (Rutto and Odhiambo, 2017). Equally importantly is the role that nurseries play in providing planting material to residents. While most species on sale are ornamental plants, there is usually a supply of fruit trees and favoured native species. Furthermore, nursery workers or owners undertake basic management of the urban forest in terms of clearing debris, removal of understory growth and disposal of waste.

Nevertheless, at a planning level, urban forests along roads are among those which have been shown to be the first deforested or degraded with the construction of new linear transport developments. The key will be ensuring that existing stocks remain intact when considering the rapid pace of development across SSA in the coming years. Hence, conducive enabling environments that safeguard against impacts are critical, and the role of effective stakeholder engagement in environmental impact assessments cannot be understated.

In-situ informal settlement upgrading and informal spaces

A key innovation in African cities that is becoming more widely adopted is *in-situ* upgrading of low-income, informal settlements. This approach requires communities and city authorities to co-design context-specific, needs-driven and appropriate plans for providing basic services, flexible land tenure, and green spaces in places where land is in high demand and there are competing interests. It responds to a call by UN-Habitat (2022) to "re-imagine" current urban systems to incorporate innovation, mitigating problems including pandemics, and maximizing benefits by becoming more equitable, healthy and environmentally friendly.

For instance, in Namibia, a cooperation between the municipality of Gobabis, the Shack Dwellers Federation of Namibia, the Namibia Housing Action Group, the **Namibia University of Science and Technology** and other international parties initiated a project aimed at creating inclusive cities. As such, some of the important activities were learning exchanges, planning studies, water delivery, **re-blocking** for security of tenure, land registration and allocation. The project resulted in an expedited process of land delivery and the growth of street trees while settlements were upgraded rather than being relocated or residents resettled in a new place (Harris, 2016).

Urban foraging

in SSA, provisioning ecosystem services are highly rated by urban communities. As a result, urban foraging, which involves collecting various products such as fuelwood, traditional medicines, wild foods, construction materials, and fish from local water bodies, is more widespread than in the Global North. For instance, in Lagos, Nigeria, 61 percent of residents frequently forage one or more products from private and public spaces (Adeyemi and Shackleton, 2023), compared to 47 percent in Kampala, Uganda, and 68 percent in two medium-sized towns in South Africa (Garekae and Shackleton, 2020). Furthermore, urban forests provide crucial land for fodder for livestock, such as in Oshakati and Gobabis in Namibia.

Despite the prevalence of urban foraging, many city authorities either prohibit or disapprove of such extractive practices. Consequently, urban foraging is not incorporated into city plans or greening projects, despite its significance as a poverty alleviation strategy. This highlights the need for policy and regulatory reforms to accommodate and support urban foraging in urban planning and development. Regulatory reforms are needed to establish appropriate zoning in order to accommodate pastoral practices in urban centres. This includes: carrying out management practices to improve fodder quality; ensuring equitable access rights throughout wet and dry seasons; setting up mechanisms to minimize conflicts among different land uses; establishing land tenure agreements for commons:[5] implementing monitoring systems; and promoting the inclusion of diverse knowledge worldviews in decision-making.

Financing models for urban forestry

Urban forestry projects exist in all countries in SSA (Ekemby and Mudu, 2022), although, in most regions, information about the levels of financing of urban forestry is limited. Nevertheless, Ekemby and Mudu (2022) recently reviewed urban forestry projects in Africa and found that most projects in SSA cities are funded by national governments. However, local or city governments are also often involved. For example, in South Africa, the City of Tshwane Metropolitan Municipality is funding USD 3 million to plant indigenous trees. Other common funders include multilateral donors, civil society organizations and private companies (Ekemby and Mudu, 2022). However, a key challenge remaining is often that national budgets designated to urban forestry do not always represent 'essential' status (de Satgé and Watson, 2018; Irlich *et al*., 2017), and thus many urban forest managers have to work below their financial needs (Pelling, O'Brien and Matyas, 2015, Ampaire *et al*., 2016; Sarabi *et al*., 2019).

Nevertheless, new funding mechanisms are helping expand the scope of public responsibilities for urban forests. For instance, some municipalities allocate a portion of stormwater fees, transportation, education and fire protection towards tree programmes. Considering that many people harvest ecosystem services because they lack financial resources to purchase substitutes, investment in urban forestry can be seen as an investment in poverty alleviation budgets (Shackleton, 2021; Contesse, Van Vliet and Lenhart, 2018). The **Sister Cities Partnership** among the municipalities of Cape Coast, Ghana and Bonn, Germany, which started in 2007, contributes to the securing of funds, building capacity and resourcing staff. Climate Insurance Linked Resilient Infrastructure Financing (CILRIF) allows municipalities access to insurance coverage through the United Nations Capital Development Fund, with pilot projects in Durban, South Africa, as well as Makati, Philippines. Tax increment financing[6] has recently started to be used in SSA. Here, a municipality or redevelopment agency acquires land or invests in infrastructure to support urban forestry, without relying on other, more costly sources of funding such as tax increases or capital reserves (World Bank, 2023). Blended financing models through public–private partnerships cover a diversity of contractual agreements characterized by different risk-sharing financing schemes and organizational forms, involving a range of actors. Table 1 summarizes some illustrative, but not exhaustive private sources for urban forestry in SSA.

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[5] Land or resources belonging to or affecting the whole of a community.

International financing is also an important and growing source of funding. For instance, the African Forest Restoration Landscape Initiative (AFR100) aims to restore 100 million ha of deforested and degraded land by 2030. To date, 33 African countries have pledged USD 210 million, with an additional USD 200 billion investment required. The Great Green Wall Initiative, which started in 2007, is another major international effort to reforest drylands across 22 African countries and 8 000 km of the Sahel, with projects in Ghana, Burkina Faso, Senegal, Mali, Niger and Ethiopia, and 167 000 ha of degraded land, including some urban centres. The initiative is in collaboration with the United Nations Convention to Combat Desertification. The **Green Climate Fund** is another important source of finance, although most investment has been in rural areas.

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[6] Tax increment financing (TIF) is a public financing method that is used as a subsidy for redevelopment, infrastructure and other community-improvement projects in many countries, including the United States of America. The original intent of a TIF programme is to stimulate private investment in a blighted area that has been designated as in need of economic revitalization.

Table 1. A selection of private sources for urban forestry in SSA

FUNDING SOURCES	BENEFITS
User charges for public spaces or botanic gardens	Identifiable recipients pay charges for enjoying benefits derived from urban forests. In cities in SSA, access fees to botanic gardens are often used for maintaining urban forests.
Certification of green buildings	This incentivizes companies to reduce carbon emissions and energy costs, thereby enhancing the performance of buildings built and sold for commercial/residential purposes.
School or community greening projects	These projects donate trees to grow in public spaces with benefits for education, reputational gains, microclimates and carbon offsetting.
Private procurement of trees by homeowners	Beautification – but often exotic, expensive ornamentals rather than invasive species.
Green bonds[7]	Usually, fixed-income[8] securities are issued to raise the necessary capital from an institutional investor.
Payments for ecosystem services (PES) and REDD+	PES schemes are generally applied to protected areas in Africa, or in rural environments.
Impact investing	An example of impact investing in SSA, is the African Forestry Impact Platform (AFIP), which aims to invest USD 500 million in sustainable forestry in SSA. AFIP was launched by British International Investment, the Norwegian Investment Fund for developing countries (NORFUND), Finnish investor Finnfund and New Forests. So far USD 200 million has been raised and AFIP is acquiring operational assets, including the largest forest company in East Africa, Green Resources (Takouleu, 2022).

The Clean Development Mechanism (CDM)	CDM urban forestry afforestation and reforestation holds potential, although significant barriers to local communities remain in SSA, with needs for more proactive regulatory, institutional and capacity-building policy strategies to improve forest data management, for example, in Cameroon (Minang *et al.*, 2008).

[7] OECD and Bloomberg Philanthropies. 2015 Green bonds: mobilising the debt capital markets for a low-carbon transition. https://www.oecd.org/environment/cc/Green%20bonds%20PP%20%5Bf3%5D%20%5Blr%5D.pdf

[8] A fixed-income security is an investment that provides a steady interest income stream for a certain period.

Note: Impact investing refers to investments "made into companies, organizations, and funds with the intention to generate a measurable, beneficial social or environmental impact alongside a financial return"

6.5. Future trends and opportunities to scale urban forestry in SSA

Which type of trees will we use in SSA cities in the future?

City authorities and local communities should prioritize large, healthy, high-quality indigenous trees that are more tolerant of shocks such as pests and diseases. Moreover, high species diversity generally supports greater resilience to climate change (Sjöman, Hirons and Bassuk, 2018). Native species should therefore be prioritized over exotic species to avoid invasive threats (Stevenson *et al.*, 2020). This will require some change in urban residents' preferences and behaviour, especially private households, which often default to planting the available exotic, ornamental species.

Similarly, selection should be suitable for site-specific conditions, attuned to current and future local growing conditions, and meet the needs of residents. Tree collections (e.g. arboreta) and botanical gardens will play a central role in identifying suitable species for planting, with an emphasis on tree quality and diversity rather than numbers. The successful establishment of trees should consider the below-ground (e.g. mycorrhizas) and above-ground (e.g. pollinators) interactions to promote longevity, conservation, and continued provision of the full range of ecosystem services provided by trees (Stevenson *et al.*, 2020).

City urban forest policy reforms

In many SSA cities, there are specific urban forestry policies and laws, although they are often implicit in broader urban policies and legislation (Wijesinghe and Thorn, 2021). Nevertheless, city authorities in SSA are increasingly developing formal policies and programmes to develop and support urban agriculture in public and private spaces. Examples of policies include the City of **Johannesburg's Food Resilience policy**, **the City of Cape Town's Urban Agricultural Policy, Nairobi's Urban and Peri-urban Agriculture, Livestock and Fisheries Policy** and the **Addis Ababa Master Plan** (Lindley *et al*., 2015). Similarly, the municipalities of Ouagadougou, Burkina Faso and Lilongwe, Malawi are actively developing green belts that incorporate urban agriculture. While these are positive trends, many more municipalities lack urban forestry policies, as well as urban agricultural policies and plans. Urban forestry policy reforms and practices should seek to directly integrate more indigenous species into urban forestry that reflect African realities. In this regard, horticultural and ornamental plant markets should shift attention to producing wild ornamental plants and indigenous species for Africa's future urban greening programmes.

Appropriate stakeholder engagement schemes such as training and consultation programmes must be strengthened for any policy to succeed in meeting its targets. There is a need to move from simply tree planting initiatives across the continent, to a complex and interrelated mosaic land management target, together with operational objectives that unite governance structures, address the equitable distribution of resources, promote training and knowledge, improve financial and technical support, hone implementation and streamline monitoring (AUC and Panafrican Agency, 2021).

Reversing inequities

The literature from Malawi (e.g. Likongwe *et al*., 2021), Namibia (e.g. Wijesinghe and Thorn, 2021; Giombini and Thorn, 2022; Thorn *et al*., 2021a) and South Africa (e.g. Gwedla and Shackleton, 2017; Venter *et al*., 2020; Cocks *et al*., 2020) has shown that poorer communities have less space and higher demand for products in green spaces. It is crucial in the future that green spaces should not be considered a luxury good for the more affluent, but an opportunity for all. Urgent efforts should be made to reverse inequities in urban forestry, promoting equitable distribution of spaces, resources and access. Additionally, there is a need to improve governance structures, provide training and knowledge, and offer financial and technical support. Furthermore, land availability and tenure should be strengthened to address environmental justice concerns.

Scaling resourcing and financing

Flexible models of public–private partnerships are needed to finance the establishment, development and maintenance of urban forests, especially where there is high climate vulnerability, risk of green gentrification or encroachment (Anguelovski *et al*., 2016). Cross-subsidization using rates and taxes from more affluent communities has shown to be successful in all areas of public service delivery and must be more widely applied in the urban forestry context. The economic case for urban forestry should be emphasized, highlighting job creation and the alleviation of multiple dimensions of poverty (e.g. see King and Shackleton, 2020), among other benefits (Shackleton, 2021; Pauleit *et al*., 2021). Governments should promote partnerships with national and international investors, showcasing successful companies and investment incentives (Mengesha *et al*., 2020). Working with planners, authorities, real estate enterprises and companies should be harnessed to develop parks in disadvantaged areas, green roofs and façades, or other urban forestry initiatives in SSA (Contesse, van Vliet and Lenhart, 2018; Vásquez *et al*., 2019).

Communicating and understanding the multiple benefits of trees

The multiple benefits of trees (and not just certain ecosystem services, such as carbon sequestration) should be widely acknowledged, more clearly defined, communicated and understood across SSA cities. Efforts should be made to inspire urban populations to engage in conservation actions, incorporating these into lifestyles while promoting mental and physical health and spirituality. There is a need to avoid oversimplified messaging that could lead to unintended consequences, such as the spread of invasive species or diseases, for example, with planting exotic tree species (Stevenson *et al*., 2020). Special tree planting days, for example, International Day of Forests (21 March), Arbor Day (28 April) or national tree days (e.g. in Angola, Benin, South Africa) can be used as opportunities to raise awareness.

Research directions

Overall, there is an urgency to build the knowledge base of urban forestry in SSA so that it is locally relevant to the SSA context and responsive to needs. Among other areas to be investigated, research should focus on: indigenous knowledge of tree species; composition in urban and peri-urban households and communities; adaptability to climate change; extension education programmes: and the types of urban forestry that are gaining support across the continent. It is important to conduct comprehensive cost–benefit analyses that consider the potential negative environmental and social impacts. Further research is also required on ecosystem services and disservices in informal areas, as well as on trends in land-use changes.

Monitoring and evaluation can better inform the demand and plans for green spaces, species required, and the necessary associated regulations. Urban authorities should establish, maintain and regularly update inventories or databases of woody species in cities (i.e. which species are available, where they are located and the condition they are in). Local authorities typically give urban forestry a low priority. As a result, except for larger and wealthier cities like Ekiti State, Nigeria (Kayode, 2010) and Lomé, Togo (Raoufou, Kouami and Koffi, 2011), most cities do not have databases or records of tree stocks (number and species), locations or maintenance practices (Chishaleshale *et al*., 2015; see Table 1). Opportunities lie in embracing innovative technologies to monitor and manage urban forests, i.e. utilizing remote sensing, data analytics and smart systems for optimizing tree health, water management and resource allocation. Indeed, advanced global forest ecosystem monitoring techniques with sufficient resolution can help to directly recognize specific species (Tucker *et al*., 2023). Furthermore, citizen science and information technology through decentralized communication have an important role to play in tracking changes and maintaining urban forests (Escobedo, 2021; Maciejewski, Currie and O’Farrell, 2021).

6.6 Conclusions

Urban forestry in SSA is alive and well and dynamic; it comes in different shapes and forms, with a variety of unique characteristics. Yet, a key challenge remains in that much is unknown. While we have a good knowledge base for a few countries, with regard to the continent as a whole, there are clear research gaps that require deeper understanding across highly heterogeneous contexts. Similarly, while some SSA cities have specific urban forestry policies, many more municipalities lack policies that directly incorporate indigenous species that reflect African realities. Hence, building a locally relevant knowledge base for urban forestry in SSA is crucial.

We envisage that by 2030, African cities will boast thriving urban forests that integrate nature seamlessly into the urban landscapes. The continent will witness a remarkable transformation as green corridors of tree-lined streets and rooftops and vertical walls become the norm, ensuring better air quality, reduced UHI effects, resilience to floods, droughts, erosion and landslides while enhancing overall quality of life and biodiversity. Urban forests will thus serve as ecological and recreational havens and create job opportunities, with residents having lifestyles underpinned by green stewardship. Future urban greening initiatives will not only plant trees, but will also include complex and interrelated mosaic land management targets, operational objectives that unite governance structures, provide financial and technical support, and address inequitable distribution and access to green spaces. Through cross-sector collaboration, local partnerships, participatory planning and community consultation, Africa's urban forestry will witness the mobilization of diverse stakeholders, including governments, non-governmental organizations, businesses and citizens. A collective effort towards sustainable urban ecosystems will inspire a new generation of tree advocates and conservationists. Africa will become a global example for comprehensive urban forestry strategies that prioritize the expansion of urban canopy cover, density and quality.

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Appendix

Table 1. Overview of tree planting projects in African cities (alphabetically by country)

No.	Country (City)	Number of trees to be planted or already planted	Duration of planting
1	**Algiers (Algeria)**	Twenty-five million trees were planted at the National Arbor Day announcement, and 17 million were expected to be planted by March 2020, in line with the national tree programme of 43 million trees. The number of trees was not mentioned in the master plan, which aims at transforming the city into a sustainable city with a garden city inside. There is also a project aimed at transforming the Oued Smar landfill (30 ha) into an urban ecological park (the number of trees is not mentioned). This project is part of the major green plan of Algiers for 2035.	Algiers 1 Tree project: 2019–2021; Algiers 2 Tree project: 2013–2030; Algiers 3 Tree project: 2009–2018
2	**Baraki (Algeria)**	More than 2 000 trees were planted after the announcement and 1 million trees are expected to be planted in one year.	2020
3	**Luanda (Angola)**	1 500 trees were planted in the city. In Rangel (urban district of Luanda), a tree planting project is planned following an announcement during the national tree day (the number of trees is not mentioned).	Luanda 1 Tree project: 2018; Luanda 2 Tree project: 2019
4	**Andulo (Angola)**	300 trees were planted.	2020
5	**Huambo (Angola)**	1 000 trees were planted, and 2 000 trees are expected to be planted.	2020
6	**Allada (Benin)**	2 500 trees were planted at the announcement.	2019–2020
7	**Parakou (Benin)**	2 100 trees were planted at the announcement by the Government of Benin and municipal authority.	2019–2020
8	**Savé (Benin)**	1 250 trees were planted at the announcement.	2019–2020
9	**Gaborone (Botswana)**	300 trees were planted.	2013

10	**Bobo-Dioulasso (Burkina Faso)**	The number of trees is not mentioned, but 6.9 ha of green spaces were planted.	2012–2014
11	**Ouagadougou (Burkina Faso)**	1 000 trees were planted, and 80 000 trees are expected to be planted.	2019–ongoing
12	**Pissa (Central African Republic)**	12 000 trees were planted, and 300 000 trees were to be planted afterwards.	2019–2020
13	**Brazzaville (the Republic of the Congo)**	160 000 trees planted.	2011–2021
14	**Abidjan (Côte d'Ivoire)**	500 trees were planted in 2019 along the road of the airport Port-Bouët 3-km long, 400 000 trees planted in Abidjan and 2.1 million planted nationwide.	2019–2030
15	**Cairo (Egypt)**	12 000 trees were planted, and 1 million trees to be planted by 2019 as part of a national project called Egypt's "100 Million Trees". 350 trees were planted, and 14 000 shrubs were also added for a vertical forest. Trees are a fundamental part of the capital park under construction in Egypt's New Administrative Capital close to Cairo (number of trees not available).	Cairo 1 Tree project: 2019; Cairo 2 Tree project: 2020–2022; Cairo 3 Tree project: 2016–2030
16	**Ismailia (Egypt)**	240 hectares of land have been reclaimed for tree planting. 500 000 ha of desert land could be reclaimed for afforestation.	2012–ongoing
17	**Massawa (Eritrea)**	The number of trees not mentioned. Tree planting activities are being conducted in the port city of Massawa in connection with the 30th anniversary of the commemoration of Operation Fenkil.	2020
18	**Addis Ababa (Ethiopia)**	More than 350 million trees were planted nationwide in a day starting from the capital as part of the Green Legacy Initiative. The number of trees was not mentioned, but there is also the "Beautifying Sheger" project to create 56 km of green spaces along the river. The city is expected to plant 5 million trees within the 20 billion trees nation plan.	Addis Ababa 1 Tree project: May-October 2019; Addis Ababa 2 Tree project: 2019-ongoing; Addis Ababa 3 Tree project: 2019–2024.

19	**Accra (Ghana)**	100 000 trees were planted in Accra, which is part of 10 million trees of the national tree programme.	2019
20	**Nairobi (Kenya)**	1.8 billion trees are expected to be planted in Nairobi and nationwide. About 10 000 trees are expected to be planted in a second project. 1 500 trees were to be planted in the Ngong Forest (25 km from Nairobi) after the announcement.	Nairobi 1 Tree project: 2018–2022; Nairobi 2 Tree project: 2020–2023; Nairobi 3 Tree project: 2021
21	**Daadab (Kenya)**	52 000 indigenous tree seedlings were planted in the refugee camp ‘IFO2’ in Daadab.	2018
22	**Maseru (Lesotho)**	Around 200–300 trees were expected to be planted in the capital and nationwide.	2020
23	**Monrovia (Liberia)**	10 000 trees were planted.	2017–2019
24	**Antananarivo (Madagascar)**	1 million trees were planted in the span of a few hours. 60 million trees are expected to be planted.	2020
25	**Lilongwe (Malawi)**	62 million trees are already planted, and more than 60 million trees are expected to be planted. 1 million trees were planted at the Dzalanyama Forest Tree Project.	Lilongwe 1 Tree project: 2020–2021; Lilongwe 2 Tree project: 2017–2018
26	**Bamako (Mali)**	18 000 trees are to be planted in the city. This is included in the national tree programme of 22 million expected to be planted by 2023 under the initiative “Un Malien, un arbre”. 150 trees were planted in the Garden of Eden in Bamako.	Bamako 1 Tree project: 2019–2023; Bamako 2 Tree project: 2019
27	**Nouakchott (Mauritania)**	As part of the Great Green Wall Initiative, 2 million trees are expected to be planted, and 200 000 trees were already planted in 2010.	2010–2014
28	**Port Louis (Mauritius)**	1 million trees are to be planted, i.e. 50 000 trees per year.	2018–2030
29	**Marrakesh (Morocco)**	3 million trees were planted. 800 000 trees were expected to be planted before the end of the year.	2017
30	**Jbilat (Morocco)**	1 million trees to be planted.	2016

31	**Ouarzazate (Morocco)**	About 635 hectares of trees were planted to act as a protective buffer between the city and the desert.	2012–2017
32	**Katembe & Madjuva (Mozambique)**	55 0000 trees have already been planted and 750 000 trees are to be planted.	2018–2020
33	**Windhoek (Namibia)**	500 trees were planted.	2019
34	**Niamey (Niger)**	20 000 trees were planted in support of the Great Green Wall Initiative. 3 million trees were planted to address heat waves and pollution.	Niamey 1 Tree project: 2018–2020; Niamey 2 Tree project: 2019–2020
35	**Abuja (Nigeria)**	30 million trees to be planted as a part of the Presidential programme starting from the capital and nationwide.	2020
36	**Sokoto (Nigeria)**	1 million trees were planted in 2016.	2016
37	**Lagos (Nigeria)**	The number of trees planted is not mentioned, but there is a 5-year tree planting green project, and specific projects also to transform the Olusosun dumpsite (100 ha) into a green space.	2014–2024
38	**Kigali (Rwanda)**	The number of trees is not mentioned, but 43 589 hectares of trees were expected to be planted starting from Kigali to other parts of the country.	2018–2019
39	**Dakar (Senegal)**	1 300 trees will be planted in the public park, located near the Mosque of the Divinity in Ouakam, Dakar (2020–2035). An urban forest park covering 10 ha was planted on the site of the former Dakar airport (2020–2035).	Dakar 1 and 2 Tree project: 2020–2035
40	**Victoria (Seychelles)**	4 000 trees were expected to be planted in this city and other parts of the country.	2018
41	**Freetown (Sierra Leone)**	Over 12 000 trees are expected to be planted.	2019–2023
42	**Mogadishu (Somalia)**	4 000 trees were planted in the capital city during Arbor Day in 2013.	2013
43	**Johannesburg (South Africa)**	90 000 trees were planted, and 200 000 trees are expected to be planted (in Soweto) in support of the 2010 World Cup green programme.	2009–2010

44	**Riverside View (South Africa)**	2 000 trees were expected to be planted.	2019
45	**Riverlea (South Africa)**	200 trees were planted and 5 000 trees to be planted.	2020
46	**Cape Town (South Africa)**	210 mature trees were planted within 2 months before the World Cup started (2010). 15 523 trees were planted in 358 beneficiary sites (2010–2017).	Cape Town 1 Tree project: 2010. Cape Town 2 Tree project: 2010–2017
47	**Tshwane (South Africa)**	115 200 trees were planted.	2002–2032
48	**Durban (South Africa)**	10 000 trees were planted for the Buffelsdraai Tree Planting project.	2019
49	**uMhlathuze city (South Africa)**	10 million trees are expected to be planted in the next five years in South Africa. This tree planting project was launched during the recent tree day in September 2021.	2021–2026
50	**Al Jabalain (Sudan)**	1 million trees were planted in a refugee camp by UNHCR.	2017–2020
51	**White Nile State (Sudan)**	1 million trees were planted.	2017–2021
52	**Khartoum (Sudan)**	The number of trees was not mentioned for one of the few remaining urban forest reserves in Sudan.	2018
53	**Dar es Salaam, Dodoma, Arusha, and others (United Republic of Tanzania, Zanzibar)**	4 000 trees were planted and 50 million trees expected to be planted.	2016–2020
54	**Dodoma (United Republic of Tanzania, Zanzibar)**	The number of trees is not mentioned (but the type of trees planted specified) for a project aimed at transforming the semi-arid Dodoma into a green city. 4 000 trees are expected to be planted to support government efforts in making Dodoma city green.	Dodoma 1 Tree project: 2020. Dodoma 2 Tree project: 2021
55	**Lomé (Togo)**	50 000 trees planted during the National Arbor Day.	2020

56	**El Agba (Tunisia)**	The number of trees is not mentioned, but 3 ha of trees planted.	2018–2019
57	**Kasserine and Jendouba (Tunisia)**	2 million trees will be planted in the areas most affected by fires in the summer of 2021. This is a national reforestation programme that focuses mainly on these two cities.	2021–2022
58	**Chinsali (Zambia)**	1 billion trees were expected to be planted in 2019. 2 billion trees are planned to be planted by the Government in three-year time frame.	2019–2021
59	**Harare (Zimbabwe)**	The number of trees is not mentioned, but the project is greening the "Sunshine City". 15 million trees are expected to be planted on 1 December (national tree day).	Harare 1 Tree project: 2017 Harare 2 Tree project: 2018
60	**Addis Ababa-Djibouti (Ethiopia and Djibouti)**	The number of trees is not mentioned, but there is a tree-planting campaign themed "Green Addis Ababa-Djibouti, Green Ethiopia" in response to the national tree-planting campaign along the railway of these countries.	2020–ongoing

Source: Ekemby and Mudu, 2022

Conclusions

As we have seen throughout the different chapters of the publication, the world's diverse regions, such as thriving forests where individual trees reach for sunlight, reflect unique perspectives. Similarly, cities must actively pursue growth and prosperity in an environmentally sustainable and equitable way. Just as trees flourish collectively when standing close together, cities must unite in their efforts to create green spaces and a protective canopy for all where possible. By fostering collaboration, sharing knowledge and providing mutual support, each city's growth can contribute to the prosperity of all, creating an interconnected green urban landscape. In this shared journey, cities can harness the power of unity, transforming their urban spaces into vibrant green places that our present and future generations will proudly call home. Initiatives and case studies implemented in the various regional contexts demonstrate that when urban environments are thoughtfully designed and managed, they can enable urban populations to minimize their ecological footprint while fostering well-being. Efforts to enhance urban forests worldwide encompass a range of actions, such as: raising awareness through educational campaigns; promoting collaboration among stakeholders; ensuring active public engagement; providing equitable access to

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Photo 1. Despite its 5 million inhabitants and a population density of almost 8 000 people per square kilometre, Singapore is the greenest city in Asia, with approximately 50 percent of its territory consisting of green spaces including 23 areas designated as forests and nature reserves.

green spaces; offering technical assistance and capacity development; integrating urban forestry into policy development plans; and promoting partnerships and knowledge exchange among professionals and institutions. There is also a growing recognition of the fundamental role that research plays in expanding our understanding of urban forests and their wide-ranging benefits. This recognition emphasizes the need to tailor strategies to local contexts, taking into account the special challenges and opportunities that arise in each setting. Through the sharing of experiences, best practices and lessons learned, global platforms and fora for interregional learning can catalyse innovation in sustainable urban development. In this pursuit, FAO stands firm in its commitment to support the world's cities as they transition towards more resilient and green urban development. At the heart of this endeavour lies the World Forum on Urban Forests (WFUF), a pivotal platform that consolidates, promotes and implements global cooperation in urban forestry. By fostering interregional collaboration, which includes both South–South and North–South partnerships, the WFUF not only expands networking opportunities, but also enables comprehensive analyses of urban challenges, thus empowering the effective implementation of UPF initiatives.

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FAO GREEN CITIES INITIATIVE

Urban forestry is one of the pillars of the Green Cities Initiative.

3 GOOD HEALTH AND WELL-BEING
11 SUSTAINABLE CITIES AND COMMUNITIES
13 CLIMATE ACTION
15 LIFE ON LAND

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